UNIVERSITY OF MICHIGAN
GENERAL LIBRARY
ANN ARBOR MICHIGAN

UNIV. OF MICHIGAN
JAN 12 1955
ENGINEERING
LIBRARY

JOURNAL

VOLUME 11, NUMBER 1 • JANUARY, 1955

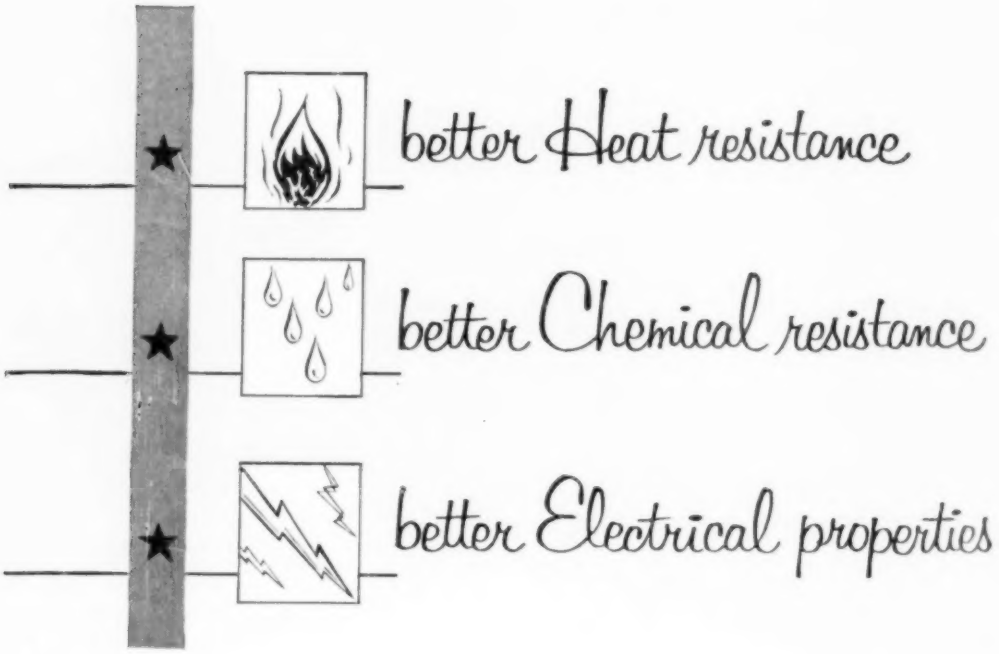
Program for Eleventh SPE Conference . . .

Complete on Pages 26-29

General
C. J. Bondley
Conference
Speaker

Important news!

EPON® resin 828 with new Curing Agent CL gives



IF YOU are among the many users of Epon resin 828 for casting, laminating or other structural applications—you will welcome this new development of Shell Chemical's continuing research program.

Curing Agent CL* produces Epon resin polymers with improved mechanical and electrical properties at temperatures as high as 300° F. After three hours' immersion in boiling water or acetone, glass cloth laminates of Epon resin 828 and Curing Agent CL retained more than 95% of their initial dry flexural strength. And with Curing Agent CL you can use the "B-stage," or pre-curing, process—permitting dry layups and specialized casting techniques.

Your request will bring you a sample of Epon resin 828 and Curing Agent CL for evaluation, as well as a copy of Technical Bulletin SC:54-10. Write for them—today.

Curing Agent CL is Shell Chemical Corporation's name for metaphenylene diamine. We do not manufacture Curing Agent CL. It is available in commercial quantities from E. I. du Pont de Nemours & Company and National Aniline Division, Allied Chemical & Dye Corp.

*A development of Shell Chemical laboratories. Patent applied for.

SHELL CHEMICAL CORPORATION

CHEMICAL PARTNER OF INDUSTRY AND AGRICULTURE

380 Madison Avenue, New York 17, New York

Atlanta · Boston · Chicago · Cleveland · Detroit · Houston · Los Angeles · Newark · New York · San Francisco · St. Louis

IN CANADA: Chemical Division, Shell Oil Company of Canada, Limited · Montreal · Toronto · Vancouver

SPE JOURNAL

Vol. 11. January, 1955 No. 1

Published monthly except July and August by

THE SOCIETY OF PLASTICS ENGINEERS, INC.

30 cents a copy $3.00 per year

Copyright by the Society of Plastics Engineers, Inc., 1955

JESSE H. DAY, Editor

Editorial Offices
SECURITY BANK BUILDING
ATHENS, OHIO

Executive and Business Offices
34 EAST PUTNAM AVE.
GREENWICH, CONN.

Officers of the Society
JOHN LaBELLE, President
DON HOFFMAN, Vice President
FRANK REINHART, Secretary
JOHN MALLORY, Treasurer
P. J. UNDERWOOD, Executive Sec'y.

Editorial Advisory Board
SAUL BLITZ, ALLAN HUTCHINGS, MARIO PETRETTI, WAYNE PRIBBLE, ROBERT SACKETT, GORDON THAYER, EDWARD VAILL

• *All correspondence dealing with business matters, membership, advertising and the like should be addressed to the Business offices listed above.*

• *All copy intended for publication in the SPE Journal should be directed to the Editorial Offices. Copy for each issue should be received at Athens, Ohio, before the first of the preceding month. Neither The Society of Plastics Engineers nor the SPE Journal is responsible for the views expressed by individual contributors.*

• *Entered as second-class matter at the Post Office at Athens, Ohio.*

BRING YOUR FRIENDS HOME FROM THE CONFERENCE IN THIS PLASTI CRAFT 14-foot Super Deluxe Runabout with strong, one-piece Fiberglas reinforced hull and handsome mahogany plywood decking. Designed and produced by Winner Manufacturing Co., Inc., Trenton 3, New Jersey, and donated by Winner, together with Owens-Corning Fiberglass and Naugatuck Chemical Co., the boat will be the first of many prizes at the Banquet Thursday evening.

INDEX

PROGRAM FOR SPE 11TH CONFERENCE—28

ARTICLES

Better Products With Statistical Quality Control, Part V

Specifications for Use Under Statistical Quality Control—Dorian Shainin 13

Plastic Pipe in the Chemical Processing Industry—B. W. Bender and J. W. Hawley 16

Plastic Dies Move into Regular Production Service—George C. Adams 19

A Sporting Approach to Strong Plastics —James W. Case 24

Cellular Polyethylene—W. T. Higgins 36

FEATURES

Book Reviews 4

Across the Editor's Desk 5

Your National Office 11

The Injection Molderscope 35

Plastics Around the World 38

News of the Sections 42

ADVERTISERS

Art Marking Specialists 8
American Cyanamid Co. 27
Bakelite Co. Div. of Union Carbide and Carbon Corp. 7
Detroit Mold Engineering Co. 53
Dow Chemical Co. 9
Durez Plastics and Chemicals, Inc. 4
Frank W. Egan and Co. 55
Electromold Corp. 51
Gering Products, Inc. 5
Hercules Powder Co. 56
Hydraulic Press Mfg. Co. 12
Injection Molder's Supply Co. 8, 48
Manco Products, Inc. 46
Marblette Corp. 47
Monsanto Chemical Co. 10
Newark Die Co. 31
Pribble Plastics Products Co. 45
Shell Chemical Co. 2
Sterling, Inc. 6
Thoreson-McCosh, Inc. 54
World Plastics Fair 49

Classified Ads 54

YOUR BEST BET

for the greatest variety of jobs...

"THE STANDARD OF THE INDUSTRY"

in

General-Purpose Phenolics

● Molders know better than anybody else why Durez 791 Molding Compound is still the "ideal" general-purpose material: *It satisfies the requirements of the most jobs.*

There are two reasons why this is so.

First, 791 offers the well-balanced properties that mean success in diversified applications whether compression, transfer, or plunger molded. Second, its uniformity from batch to batch means that length of flow, speed of cure, dimensional stability, and properties of molded pieces do not vary. Let Durez 791 help you satisfy the most customers. For information and cooperation, contact Durez Plastics & Chemicals, Inc., 1112 Walck Road, North Tonawanda, N. Y.

DUREZ

PHENOLIC RESINS

MOLDING COMPOUNDS

INDUSTRIAL RESINS

PROTECTIVE COATING RESINS

Phenolic Plastics for the New Era of Competition

Book Reviews . . . . .

FIBERGLAS REINFORCED PLASTICS, Ralph H. Sonneborn and others; Reinhold Publishing Company, New York, 154: $4.50.

For those interested in a good general outline of the rapidly growing field of reinforced plastics, as well as a handy source of reference tables, this book is probably the best available to date.

Liberally illustrated, it brings together such considerations as the nature and uses of fiberglas reinforced plastics (hereafter referred to as FRP), materials and manufacturing processes employed in the field, and numerous tables of properties of FRP laminates of many types. A glossary and bibliography are also included.

In addition, there are three excellent chapters on FRP design.

In the first, the author points out a number of general factors that should be considered for functional performance of FRP parts, as well as moldability.

The second, by Prof. Albert G. H. Dietz, of MIT, presents the design theory behind the behavior of reinforced plastics. Mathematical analysis is made for plain and composite FRP plates, bending of beams, action of plate and rib construction, and sandwich construction (2 thin, strong facings with a thicker core of lighter material).

Practical FRP structural design is covered in a third chapter by Alton S. Heyser of Reed Research, Inc. He shows how to select the thickness and glass content of a laminate. Since there are various combinations of resins and fiberglass which offer approximately equal strengths, charts and tables are presented that readily help the designer obtain the lowest-cost solution.

In addition to "design," the book is well detailed in its coverage of types of fiberglass reinforcement available, applications for same, and machining techniques. It also outlines the different molding techniques commonly used. However, the book is less extensive in its treatment of some other important aspects of the reinforced plastics field.

Specifically, though the author states he didn't attend this to be a text on resins and refers the reader to the supplier companies for detailed information, the importance of proper chemical formulation and the many problems involved therein tend to be understated. Also there are certain details that almost every FRP fabricator has difficulty with to some degree, such as surface finish, design of molds, shrinkage and warpage, fastening and bonding, etc. These are mentioned, but not in great detail. Yet the novice just entering the reinforced plastics business will soon find out that attention to such details will often spell the difference between profit and loss.

Keeping in mind that FRP fabrication isn't quite as straight-forward as one may be led to believe, this book will enable the reader to get a very good general concept of what the FRP field is all about.

Leon J. Brettler

---

* THE MARBLETTE MIRROR is available (currently being published quarterly) on a free subscription basis. Coupons in each edition of this company publication offer samples of resins and free technical information. Names of individuals to be placed on the mailing list should be sent on a company letterhead to Dept. SPE, The Marblette Corp., 37-21 Thirtieth Street, Long Island City 1, New York.

Across the Editor's Desk . . . .

● What could be more wonderful for a young man who is now in college and wants to enter the plastics business? Princeton University offers fellowships for graduate study in their Plastics Program. The fellowships offer stipends from $1500 to $2100 and the work in the plastics laboratory leads to an M.S. degree in Engineering. Write Louis F. Rahm, Plastics Laboratory, 30 Charlton St., Princeton, New Jersey for the details.

● Ever give a talk and wish you had some nice colored slides to show what you were talking about? An SPE committee is working on it—the idea is to create a complete file of color slides showing every type of operation in shaping plastics, using machines, making materials —the whole works. Slides are to be kept at a central office and loaned to SPE members for use in educational talks and SPE affairs, as well as in technical and university classrooms. But the first step is to get the slides. If you or your company can help in this worthwhile project, write to J. H. DuBois, Mycalex Corp. of America, Clifton, New Jersey.

● The Plastic Institute in England is the one society most like SPE, and their quarterly publication "Transactions and Journal" is always interesting to your editor. The first part of the magazine has news of technical meetings and reports of local section activities and papers. The bulk of the magazine consists of articles that are well-written and of high technical quality. Articles in the July issue cover chemistry of lignin, plastic films for packaging, finishing of plastics, furane resins, the effect of temperature and orientation on the mechanical properties of plastics. Also an article on education in plastics—of which more in a moment. The articles are usually followed by a few pages of discussion, and questions and answers on the subject.

About plastics education—they seem to be at about the same point that we are in the U.S., with some technical school opportunities and some college work. And there, as here,—but let me quote, "difficulty in finding candidates of the required standard of education who were interested in making a career in the plastics industry."

Overseas membership pays no entrance fee, and subscription comes to a very modest sum. Plastics Institute and "Transactions" should be of considerable interest to many SPE members. Write to The Plastics Institute, The Adelphi, Adam St., London, W.C. 2.

● Can you read a Jugoslav journal? And abstract it for Plastics Around the World feature of the SPE Journal? If you can—and will—write to SPE Journal, Security Bank Bldg., Athens, Ohio.

(Please turn to page 6)

that's why it's Sterlco

TEMPERATURE CONTROL UNITS

From a cold start through a full production run, Sterlco's "fast service" and extremely high degree of sensitivity assure quick warm-up and accurate, automatic mold temperature control for faster production and minimum rejects.

here's why . . .

1. Super-fast 9000 watt unit on each side for quick starts
2. Small total water capacity—no excess thermal carryover either way.
3. Super-sensitive, accurate HEATING CONTROL with extremely fast reaction time.
4. Flexible, modulating COOLING CONTROL—not on or off.

MODEL 6003 — DUAL

MODEL 6002 — DUAL

The mobile temperature control unit functioning in leading plastics plants from coast to coast. Ready to operate when connected to electricity, water and drain.

MODEL 6012 — SINGLE

MODEL 6003 — DUAL
A compact unit designed for permanent installations. (Can be equipped with casters). Requires approximately 50% less floor space than Model 6002 with same capacities.

MODEL 6012 — SINGLE
A highly efficient unit for use where a single stabilized temperature is adequate as in small molds or molds with shallow cavities. Works well where metal molds provide for water circulation in vacuum forming, as well as to control temperatures of calender rolls in sheet extrusion. Can be used with above DUAL models where MORE than TWO temperatures are required.

Send for descriptive bulletins — DO IT NOW!

MANUFACTURERS OF TEMPERATURE CONTROL EQUIPMENT SINCE 1916

INDUSTRIAL CONTROL DIVISION

STERLING, INC.

3732 N. Holton St., Milwaukee 12, Wisconsin

Across the Editor's Desk . . .

(Continued from page 5)

● The GE Plastics Alumni will hold a reunion-dinner on January 19th, at the Chalfonte-Haddon Hotel in Atlantic City.

All members of the Alumni Association are requested to notify their associates to make sure that a maximum attendance is achieved. Arrangements are being made with the hotel so that an announcement of the exact location for the dinner will show on the bulletin board in the hotel lobby.

Mr. Wayne Pribble will serve as toastmaster at the dinner. J. H. DuBois will make the arrangements for the meeting.

Materials for Product Development 1954. Published by Clapp and Poliak, 341 Madison Ave., New York. 159 pages, $7.50.

This book is the proceedings of the Basic Materials Conference held in Chicago in May 1954, and consists of a series of papers presented there together with the audience questions and the speaker's answers. Chapters include New Developments in Engineering Materials; Rockets and Guided Missiles; Precision Castings; Powder Metallurgy; Forging, Extrusion and Stamping; How, When & Where to Use Plastics . . . Carbon Graphite . . . Ceramics . . . Glass; Adhesives and Adhesive Bonding of Metals and Plastics; Heat-Resistant Coatings for Steel; and How to Set Up and Operate a Materials Department.

The book should prove well worthwhile to those who are responsible for knowing and selecting the right material for each job.

Travel With Your Friends!

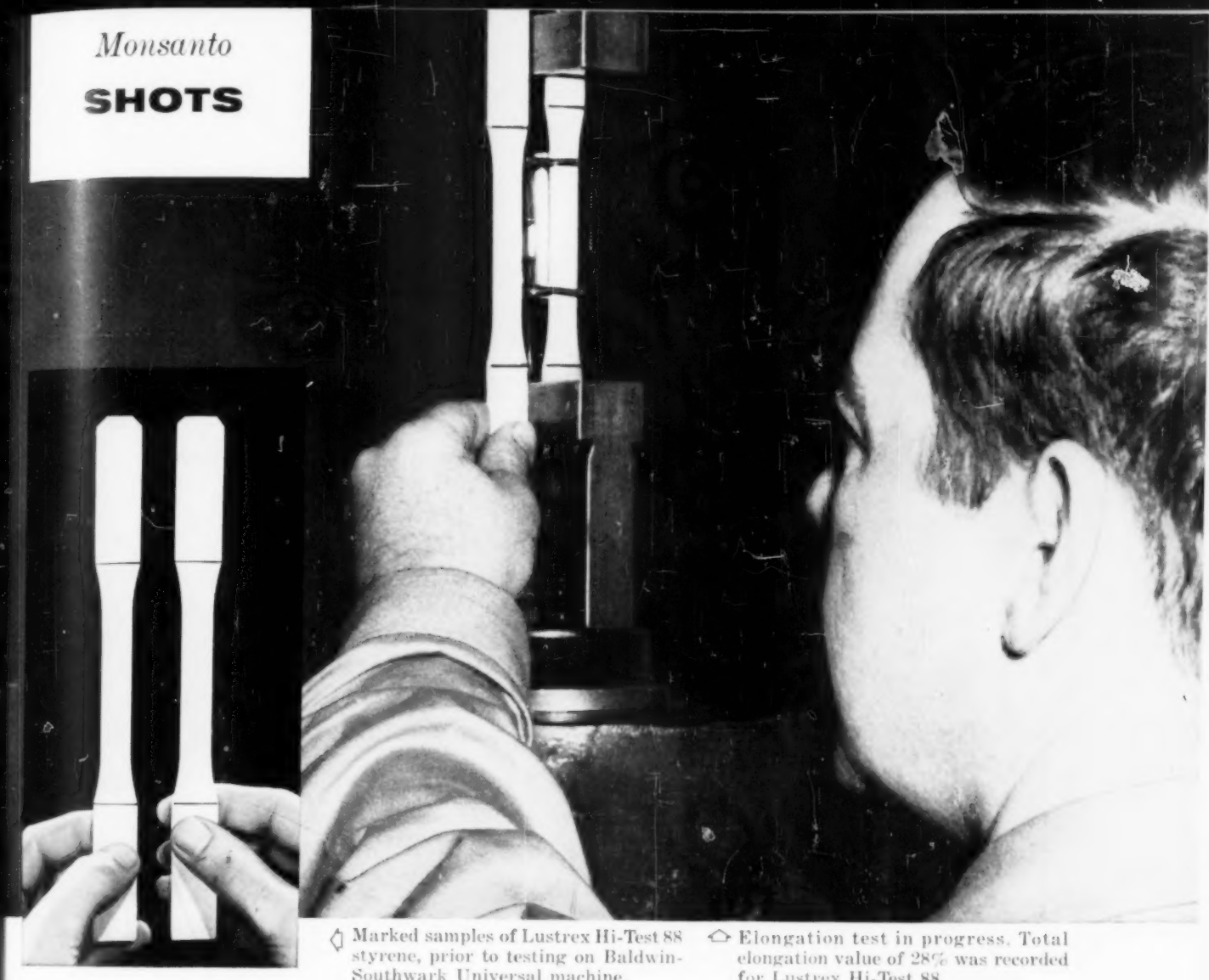
Have Fun Going to and Coming Home from the Conference

Last month the **Journal** printed a list of Transportation Chairmen for many of the Sections. If you were not able to find out where to sign up for Group Travel to the Conference because your Section was not listed, ask your President or Vice-President. The following have been added to the list and will be glad to help you in getting Travel Reservations in their areas. There is still time if you contact your Chairman **AT ONCE:**

Chicago	Ray Daniels Amos Molded Plastics 1005 Belmont Ave. Chicago, Ill.
Cleveland-Akron	R. B. Treer The Warner & Swasey Co. 5701 Carnegie Ave. Cleveland 3, Ohio
Connecticut	David A. Edwards Naugatuck Chemical Co. Naugatuck, Conn.
Detroit	Iver Freeman Reed-Prentice Corp. 415 Curtis Bldg. Detroit 2, Mich.
Northern Indiana	R. E. Valentine 602 Ft. Wayne Bank Bldg. Ft. Wayne, Ind.

Monsanto

SHOTS



◇ Marked samples of Lustrex Hi-Test 88 styrene, prior to testing on Baldwin-Southwark Universal machine.

⬠ Elongation test in progress. Total elongation value of 28% was recorded for Lustrex Hi-Test 88.

Lustrex Hi-Test 88 is tough!

Elongation test proves amazing ductility of Monsanto's high impact styrene!

By submitting sample bars of plastic materials to a terrific tug-of-war, the Baldwin-Southwark Universal Tester can measure their elongation values.

In these punishing tests, sample bars of Lustrex Hi-Test 8 styrene achieved a total elongation value of 28%.

This phenomenal ductility is 30% greater than other leading high-impact materials tested—and from 10 to 15 times greater than general purpose styrene.

Lustrex Hi-Test 88 has other outstanding toughness features. It offers impact resistance up to 500% higher —and flexural fatigue values that are 15 times greater than unmodified styrene compounds.

You also get superior moldability and flow when you use Lustrex Hi-Test 88. Surface gloss and color stability are excellent. Suitable for injection and compression molding, extrusion and vacuum-forming.

For proof that Monsanto's high impact styrene can improve the quality and sales appeal on the products you mold, try Lustrex Hi-Test 88 on your next job. Write Monsanto Chemical Company, Plastics Division, Dept. SP-1 Springfield 2, Mass.

For superior toughness, specify **HI-TEST 88**

MONSANTO

LUSTREX Styrene Plastic

Silk-Screening

PLASTIC decorating

Off-Set Printing

Hot-Stamping

Moulders and Fabricators requiring trade marking and decorating on plastic products.

The above three processes are applicable on all types of plastic such as nylon, polystyrene, polyethylene, acetate, vinylite, acrylics, bakelite, cast resins and fibre.

Our facilities are the largest in the country and we contract to do any marking required regardless of quantity, shape or size.

"Quotations Promptly Given"

Art ROLL LEAF STAMPING CO.
Marking in all its phases
MARKING SPECIALISTS, INC

4201 Hudson Blvd., North Bergen, New Jersey
UNion 5-0452 LOngacre 4-8370

GENUINE IMS SILICONE SPRAY
SHIPPED AT ONCE -- ONLY FROM
INJECTION MOLDERS SUPPLY
3514 Lee Rd. • Cleveland 20, Ohio

experienced molders already know
"You get just what you pay for!"
that's why they specify—
IMS SILICONE SPRAY
Balanced-Proven Formulation and Faster to Apply from Exclusive All Metal Nozzle

It's Delivered FREE—It Costs Only
$2.00 ea. (Sample) $1.50 ea. (Dozen) $1.37 ea. (Gross)

Beware of Imitations!

New Membership Applications Received During December 1954

BALTIMORE-WASHINGTON
Jack Arthur Peck

CENTRAL OHIO
Hunter L. Boice
James H. Garard, Jr.

CHICAGO
Bailey H. Barnes
Franklin E. Eck
Walter F. Hosek
Frederick M. Lauritzen
Philip L. Mates
Richard P. Mates
Eugene Szakafits
Richard K. West
George E. Whittles

CLEVELAND
Robert P. Blaine
Evert A. Earles
George Hackim, Jr.
Samuel A. McElroy, II
Paul C. Szabo
Jerry Zeelo

DETROIT
Adrian L. Conway
Raymond G. Davis
Abram Peters
Meyer Tennebaum

GOLDEN GATE
Richard A. Newhall

INDIANAPOLIS (Provisional)
Fred H. Drummond, Jr.

KANSAS CITY (Provisional)
John R. Albert
Earl Bandlon
Robert L. Boatman
Elmer M. Davis
Millard L. Davis
Vincent C. Dollins
Philip G. Fleming
Harry E. Fortune
George K. Frischer
Howard M. Gadberry
Jay H. Gaines
Michael J. Grebowiec
George W. Heflin, Jr.
Paul A. Marehauf
William R. Margruder
Clarence M. Moore, Jr.
W. H. Prelogar
Robert Thomson
Joseph F. Ward
Clark Williams
Laurence H. Wolfe
Ralph C. Hedges

MIAMI VALLEY
John R. Connor
Lloyd E. Hall
Frank M. Maess
Donald Suer

NEWARK
L. William Jordan

NEW YORK
Kenoal LeRoy Briggs
H. R. Burgess
Monte L. Levin
Dale L. Orloff
George Pandolfo
C. Stephen Schwendler
Howard B. Sindel

ONTARIO
Hugh Cairns
Karl Fabricius
O. B. Wilson

PHILADELPHIA
Richard E. Rafstedt

QUEBEC
D. F. Mason
James Storey
F. B. Upton

ROCHESTER
Howard J. Hill, Jr.

ST. LOUIS
James P. O'Neill

SOUTHERN CALIFORNIA
William C. Jamison

SOUTHERN
F. J. Scott

SOUTH TEXAS
James F. Bailey

TOLEDO
John R. Larimore

UPPER MIDWEST
Elmer J. Buzicky

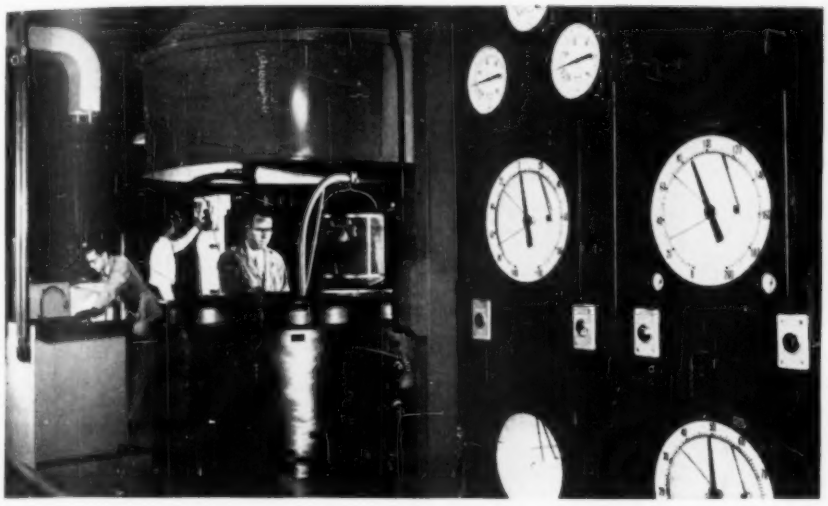
WESTERN NEW ENGLAND
Kenneth R. Allen
William J. Birmingham
Edwin N. Fitzpatrick
Richard A. Gnecco
Wesley N. Stickel
Rolland C. Trudeau

NON-SECTION
Renato Fecchial
G. E. T. Stimpson

Introducing

Plastiatrics

DOW'S CLINICAL APPROACH TO HEALTHY PLASTICS APPLICATION



Testing section of Dow Plastics Laboratories.

PLASTIATRICS HELPS YOU CHOOSE AND USE PLASTICS CORRECTLY

Are you getting the most out of the plastics you need? Do you have the best or the latest or the most for your money? Are you satisfied that plastics are right for the job? That's where Plastiatrics comes in . . . to provide a continuous study, analysis and treatment of plastics application . . . to understand, prevent, or cure plastics problems.

What is Plastiatrics

Plastiatrics sounds like a medical term. It's no accident. Since Dow's first plastics were made, we have subjected them to: *diagnosis*, to determine their limitations and complaints—*prognosis*, to determine the course and termination of manufacturing problems—and *treatment*, prescribing a course of action or physical remedies for their ailments. Professional analysis and experience is making it possible to *cure* many plastics problems and prevent possible afflictions. The general practice of scientific inquiry and treatment of plastics and their healthy uses is a profession at Dow. Plastiatrics, we call it.

The Plastiatrics Laboratory

Good research requires modern equipment, but the tools are only as good as the men who use them. Dow Plastics Technical Service is staffed by engineers and technicians who have devoted their careers and their skills to the study of plastics materials, processes, testing methods and their evaluation. The knowledge and experience these men have gained are tremendous in scope. They work with standard commercial fabricating equipment, not laboratory models, to integrate materials and processes with careful attention to practical economics. Experiment and development can be carried out on commercial scale from raw material formulation through specialized processes and finishing. Field service in fabricating plants and participation in trade standards committees further extend the work of the laboratory. The reliable reports and engineering data of Plastics Technical Service are the foundation of Plastiatrics.

Plastiatrics Helps Industry

Dow seeks to promote the use of plastics wherever that use is sound, and discourage it where other material can be used more advantageously. With Dow, the interest of the manufacturer or molder is paramount. Problems and their solutions or supporting data are stated in standard engineering terms so that technically trained people in other fields can use them. Dow will furnish confidential evaluation of finished or proposed plastic parts or their blueprints. Service work may include consultation on special developmental techniques. Considerable experience is available to the manufacturer with regard to appropriate dies, jigs and fixtures and molded parts. Materials are modified or developed according to the requirements of industrial application. Like preventive medicine, Plastiatrics can ward off trouble before it starts.

Plastiatrics Series to Follow

Results of clinical reports will appear in these pages from time to time. For a complete summary of Dow products and services, write for "Dow Plastics Materials and Technical Services", The Dow Chemical Company, Plastics Sales Department PL 453Z, Midland, Michigan.

DOW POLYSTYRENE FORMULATIONS:

- **Styron®** 666 . . . Dow general-purpose polystyrene.
- **Styron** 688 . . . for controlled flow and controlled pressure distribution in the mold cavity.
- **Styron** 777 . . . for medium-impact strength.
- **Styron** 475 . . . for high-impact strength and high elongation.
- **Styron** 475 **sheet** . . . for vacuum or pressure forming.
- **Styron** 480 . . . for extra-high-impact strength.
- **Styron** 700 . . . for high heat resistance.
- **Styron** 637 . . . for improved light stability.

you can depend on DOW PLASTICS

DOW

"Texas Special" locomotive and cars molded by **The Lionel Corporation,** Irvington, N. J.

Golden Tuba molded by **Emenee Industries, Inc.,** 200 Fifth Avenue, New York, N. Y.

Regina Electrikbroom Jr. sold by **Marilyn Products, Inc.,** Irvington, N. J.

High-Impact Styrene toys head the play for bigger markets

Beginning to notice the new shock-resistant styrene plastic toys this year? Look at these, made from BAKELITE High-Impact Styrenes. Big and small, they're handsome, durable, impressive examples of better products designed for improved sales.

Two BAKELITE High-Impact Styrenes are available for injection molding. TMD-5151 offers 8* times the impact resistance of general purpose styrenes. TMD-2155, the extra-high-impact material, has 18* times greater impact resistance. Manufacturers can make their choice based on fabricating costs and toughness required.

Get complete details on TMD-5151 and TMD-2155 by writing for your copy of BAKELITE Molding News, Vol. 1, No. 6. Also ask to be placed on the mailing list for this up-to-the-minute source of news in plastics.

*ASTM average Izod test using notched ¼-in. bar at 75 deg. F.

BAKELITE
TRADE-MARK
High Impact Styrenes

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N.
In Canada: Bakelite Company, A Division of Union Carbide Canada Limited, Belleville, Ontario

GREATEST VARIETY . . . LARGEST RESOURCES FOR PLASTICS KEYED TO YOUR NEEDS
Impact Styrenes • Acrylonitrile Styrenes • Polystyrenes • Polyethylene
Phenolics • Vinyls • Epoxies • Polyesters • Fluorothenes

YOUR NATIONAL OFFICE

"The objects of the Society shall be to promote in all lawful ways the Arts, Sciences and Engineering Practices and Standards connected with the utilization of plastics."

"Growth—Through Engineering"

This theme of the Society's 1955 Annual Technical Conference will be developed from the current picture but with the intention of pointing the way to your future **growth**—through engineering.

Certainly in any business, success is not obtained by riding along on past efforts and accomplishments. Especially in the rapidly developing and changing plastics industry it is essential that everything possible be done to keep astride if not ahead of the industry's growth.

The Society of Plastics Engineers exists primarily to provide you with information necessary for you to keep up with the latest developments in plastics. To paraphrase an old saying, though, the Society can not help you unless you help yourself. Can you afford to pass by this opportunity to obtain leads to your future—through engineering?

Place: Haddon Hall Hotel, Atlantic City, New Jersey

Time: January 19, 20, 21, 1955

Expected attendance: 2,000: please, please register in advance!!! Acknowledgments: To the Society's Philadelphia Section for doing a really first-rate job in the usually fine Philadelphia way.

Newark Section Unwraps Plastics Training Program

Congratulations to—

The Newark Section's Education Committee which has succeeded in having established at the Newark College of Engineering two courses on plastics—details below!

THE NEWARK COLLEGE OF ENGINEERING, RESPONDING TO THE DEMAND FOR TRAINED PERSONNEL IN THE PLASTICS INDUSTRY, AND IN COOPERATION WITH THE SOCIETY OF PLASTICS ENGINEERS, NEWARK SECTION, OFFERS TWO PLASTICS COURSES.

INJECTION MOLDING	COMPRESSION
Thermoplastic Materials	Thermosetting Materials
Molding Techniques	Molding Techniques
Design of Molds	Design of Molds
Injection Machines	Compression Presses
Instrumentation	Auxiliary Equipment
Color Blending	Electronic Heating
Product Design	Product Design
Cycle Control and Automation	Automation

A plant inspection trip is planned for each of these courses.

Instructors—Mr. Milton A. Sanders, Project Engineer, Sun Tube Corp., Hillside, N. J.; Mr. John Lombardi, Plant Superintendent, Shaw Insulator Co., Irvington, N. J.

ALSO OTHER SPECIALISTS FROM THE PLASTICS INDUSTRY—

SESSIONS

This program is offered in twelve weekly, Tuesday evening, sessions as follows:

PLACE: Newark Academy

TIME: 7-9 P.M.

STARTING: Tuesday, January 4, 1955

TUITION AND FEES: $20

SESSIONS

This program is offered in twelve weekly, Thursday evening sessions as follows:

PLACE: Newark Academy

TIME: 7-9 P.M.

STARTING: Thursday, January 6, 1955

TUITION AND FEES: $20

This is the first step in the setting up at Newark College of a full 3 year certificate program to help men in their area promote themselves in the plastics industry by obtaining additional training in their industry.

Attention Section Presidents and Education Chairmen: write Mr. Robert Bartlett, Natvar Corporation, 221 Randolph Avenue, Rahway, New Jersey, for suggestions on means of establishing such a program for your members.

Southern California Section Cooperates with ASTE

The Southern California Section of the Society of Plastics Engineers will sponsor a technical session pertaining to plastics at the Twenty-third Annual Meeting of the American Society of Tool Engineers in Los Angeles, California, March 14 through 18, 1955. In co-operation with another professional association SPE members will thus have an opportunity to communicate the plastics engineer's needs to the engineers of an industry on which you depend for essential equipment.

New York and Newark Sections Cooperated with ASME

In the fall the New York and Newark Sections of the Society conducted a symposium on plastics engineering for the metropolitan members of the American Society of Mechanical Engineers. It was most successful. Attending were the men in the New York area who do product engineering and product design. What could be more important than to increase their knowledge of plastics since here were men who most frequently have the responsibility of **choosing the material to be used for a product!**

Other engineering societies are most anxious to work with the Society of Plastics Engineers for the mutual benefits that can be obtained thereby. Why not investigate the possibility of such corporate meetings in your area?

On behalf of the National Officers, Directors and the staff, may I wish you a happy and prosperous 1955.

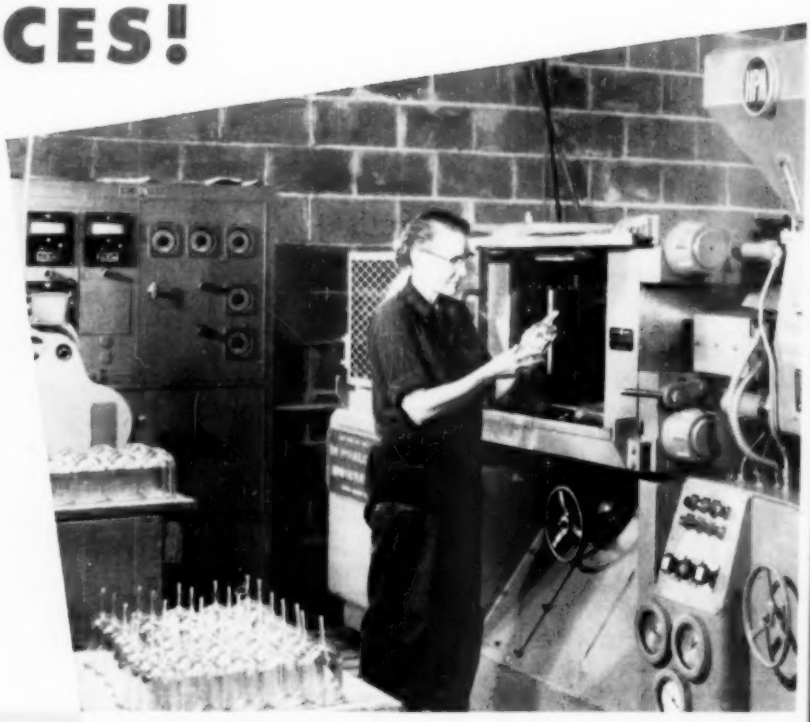
See you in Atlantic City!

P. L. Underwood

Executive Secretary

standard HPM MOLDS BAKELITE C-11 TO CRITICAL TOLERANCES!

Norgren Vitalizer Unit, a combination air line filter and oil fog lubricator. Heavy, durable, transparent bowls and baffle are molded by Chaney Plastics of Denver.



Chaney Plastics of Denver Solves Tough Production Problem with Standard H-P-M Injection Machine.

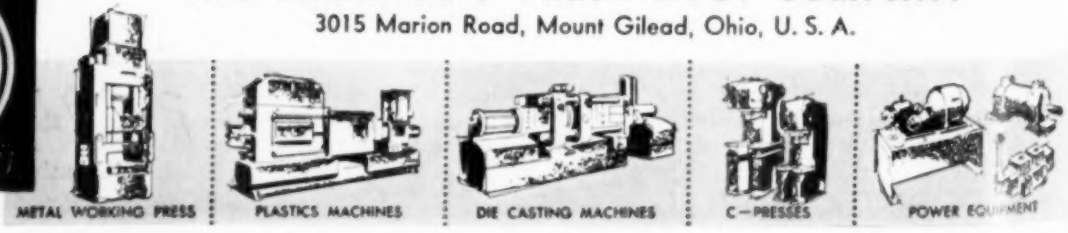
Here's one to remember . . . when quality and dimensional tolerances are critical and molded parts undergo rigid inspection, you can rely on standard H-P-M injection machines to handle the job. In this instance, the Chaney Plastic Molding Co. of Denver, installed a new H-P-M 9 oz. and within two hours after installing the dies were producing quality bowls for the C. A. Norgren Co. This, in itself, must be some sort of record, for both machine and dies were new. The bowls are designed with an 8X safety factor, are .300" thick, Bakelite C-11 material. One of the bowls has a brass insert in the bottom. Critical dimensional tolerances are maintained.

It's another typical H-P-M success story — one that may have a parallel in your plant. If you've an injection molding problem you can be sure there's an H-P-M for the job. Get in touch with your H-P-M field engineer today.

HPM

THE HYDRAULIC PRESS MFG. COMPANY

3015 Marion Road, Mount Gilead, Ohio, U. S. A.



The Molder Needs to Know How to Make . . .

Specifications

For Use Under Statistical Quality Control

Dorian Shainin
Rath and Strong, Industrial Consultants
Boston, Massachusetts

Quality control is part of production, not of inspection. S.Q.C. must set realistic and very definite specifications for the product. Properly used, S.Q.C. can also be used to find the variable factors which are most responsible for production costs.

This article is the fifth in a series written for the plastics molder by the Statistical Quality Control Committee of SPE, under the chairmanship of L. M. Debing.

A SPECIFICATION FOR A RADIO cabinet tersely called for a crush strength not less than 250 pounds. Five cabinets were taken from a lot of 2500 and subjected to a 250 pound test. One failed.

It was not clear from the specification what this meant. What should be the disposition of the remaining 2495 cabinets?

Five more were selected and tested. This time all five passed. Had this been the result with the first five tested, the question would not have come up. The lot would have been accepted. But would this decision be correct?

The same lot can produce samples that give different results. All the pieces cannot be economically tested. Readers of this series on Statistical Quality Control might now be wondering how the concepts so far presented might help solve this "irresolvable" dilemma in the use of contemporary specifications.

Besides getting help from a statistical approach, specifications do need to be more specific. Just think of the possible interpretations of a requirement for a maximum burning rate of 6 inches per minute. Does it mean that not one of the group sampled shall exceed 6 inches per minute; that the average of those tested be less than 6; or that at least one of those checked shall burn at less than 6?

We can look forward to better specifications for the plastics industry. Perhaps it is because, in any modern industry, change is inevitable. Progress may be slow, since certain people in industry often resist change. But we can be philosophical about the matter. We can say the "inevitability" of change will eventually triumph.

What Constitutes A Good And Workable Specification?

For a base upon which to build an answer to the question expressed in this heading, let us first state the requirements for a good specification as universally accepted generalities. Limits should be given that define products which will be successful in meeting real requirements. Typical areas of coverage include dimensional fits and clearances, minimum tensile and impact, crush strength and similar functional properties all the way to maximum inches per minute flammability, weight loss resistance to solvents, water absorption, and electrical properties. If, at the same time, these limits result in products that can be readily made, considering the present stage of fabrication technology, we have a good specification. The availability of practical standards, against which the limits can be judged, and the inclusion of rules for inspection transform the good specification into a workable one. A specification which does all this represents a successful balance between the producer's and the consumer's points of view.

Prior to S. Q. C. such general statements only occasionally could be, without question or argument, applied to a specific set of limits. Too often they had been set by an engineer or a customer on the basis of meagre, if any, completely applicable data. Many limits had been set only from theoretical considerations. And because people will resist the change to more reliance on the statistical approach, many limits continue for awhile to be set this way. Subconsciously (and often consciously) specification writers set conservative limits from the standpoint of requirements and so move away from our definition of a good specification. Too little consideration is given to the problem of defining a product that can be readily made.

S.Q.C. can now make available to engineers and customers more facts, to replace previous opinions, which bear on all phases of getting out workable specifications. Answers can be had to such questions as: What is the natural tolerance or inherent capability of a given production process; how much of this total variability comes from each of, say, four factors—raw material, temperature, pressures, and catalyst—and how much comes from all the remaining factors not so tested statistically; what would happen in service use of the product if certain characteristics were simultaneously at given points in their "tolerance" bands; and how often could they be expected to be there simultaneously; and so forth? There

is even a special relative cost evaluation approach to determining which of the innumerable requirements for a product should be subjected to statistical analysis for such answers to make the return financially greater than the cost of the tests.

The natural tolerance of a given production process refers to the numerical width of the band of the expected variation of individual results when the process is operating in statistical control. The third article of this series "The Concept of Control Charts" showed that this special control condition can be expected to exist when the points for averages and those for ranges from successive samples are falling within the control limits of the Shewhart Control Chart. To get the natural tolerance or process capability you multiply the numerical distance between the control limits for averages by the square root of the sample size.

Example: .005" between control limits for $\overline{X}$.
Sample size = 4 pieces
process capability = .005 x 2 = .010".

A later article of this series will describe the analysis of variance, which can show how much of this total variability comes from the variability of each of certain suspected factors and how much comes from all the remaining factors as a group, which have not been selected for the analysis. As an introduction to analysis of variance, here is a brief description of the two techniques which make it possible, balancing and randomizing.

An experiment is planned to consist of a series of test runs, each to be made with a certain combination of the factors in question. Say three levels or values of each factor are to be studied. One combination can be with all factors simultaneously at their lowest level, another the same but with one factor at its intermediate level, and then possibly with two of the factors changed to their intermediate level and so forth. The design is laid out systematically in the one of several possible statistical patterns which will best furnish the answers in question and with a selected reliability. But the combinations are so chosen that when the results common to one level of a factor are compared with the results common to another level of the same factor, all the levels of all the other factors will have contributed equally to each of those two sets of results. So the effects of the other factors have been *balanced* out, and the comparison will estimate the difference in results attributed to moving from one level to another just one factor alone. When all the comparisons have been computed, similar estimates are individually obtained for all levels of all factors.

Randomizing is used to prevent any one or more of the remaining, and non-selected, factors from having anything but a random effect upon these estimates. Thus this effect can be handled statistically. It is usually the order of the test-run that is made to follow the random pattern in the application of randomization.

The problem in service of certain characteristics being simultaneously at given levels is another situation solvable by an analysis of variance. Here we are implying that a particular combination of levels of different factors can sometimes give a result all out of proportion to what the experiment shows can be expected as each factor might be taken to a different level. Such an unusual result is called an *interaction* effect.

How often might such critical combinations exist in the field is a matter of a probability calculation from observations of the distributions of the factors in the field. Such calculations are part of good S. Q. C. courses given each year in many parts of the country, usually sponsored by the American Society for Quality Control.

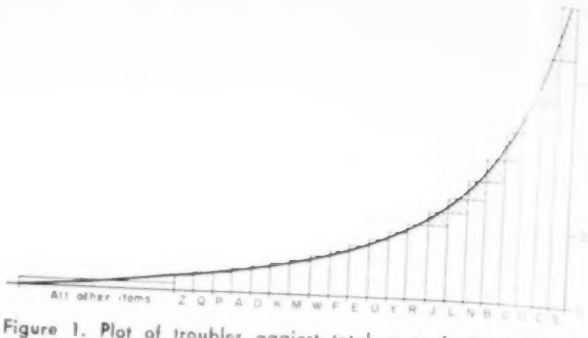


Figure 1. Plot of troubles against total cost of all troubles shows the molder how to get maximum cost reduction.

To illustrate the relative cost evaluation approach to determining which requirements should be subjected to statistical analysis, Figure 1 shows an orderly plotting of troubles against per cent of total cost of all troubles with the items produced. Trouble S was the most costly for the past period being studied. Its percentage of the total cost is shown by the cross-hatched bar (about 15 per cent). Trouble C was the next most costly (about 10 per cent), and so forth as we move to the left. The curve connecting the tops of the bars represents the accumulated cost.

Whenever one makes this sort of an analysis, he almost always finds a noticeable change of slope occurring in the accumulated curve. The place where the curve starts to flatten out can be considered a point of diminishing returns. In the illustration we stopped showing the increments of cost per trouble at this region. Notice that a reduction of 75 per cent of the total cost would accompany a successful trouble-shooting application of S.Q.C. techniques on only eight troubles. The general experience is that a large cost is concentrated among relatively few items.

In each case in the author's experience, in which the foregoing approaches have been used, one or more of the following were found:

a. Contrary to general belief in the shop, the trouble-some process could easily meet the specification requirements. In some cases the operator was making unnecessary adjustments that were shifting an otherwise stable distribution of results. In others, the automatic control mechanism increased the total variability by introducing this type of adjustment hunting. In these cases the specifications are realistic, but the process was being operated in such a way that its inherent capability was being unnecessarily exceeded.

b. The specification set up controls for some factors which analysis of variance showed had little effect, while the specification disregarded *one* factor that had a major effect on the desired results. In plastics, the situation could be that the specification put forth by the supplier of plastic material to the molder was not calling out a very pertinent requirement.

c. A pertinent factor was being controlled, but at entirely the wrong level for the desired results. During removal of product from the mold, for example, a given factor is being controlled to minimize distortion, but a different time-temperature point for this step would do much better.

d. Two factors, when simultaneously at a particular pair of levels, gave a result significantly different from what would be expected from plotting the

change in results due to changes in each factor alone. This interaction effect only can be evaluated numerically (and often only can be discovered) by the use of certain experimental designs, which are part of analysis of variance. A particular pre-heating-molding cycle combination might be a case in point.

In addition, it has generally been found that while most tolerances are unnecessarily close (tight or conservative), from a functional standpoint, very few could not be met economically with the aid of quality control techniques of the appropriate type. Also much corrective and experimental work in industry toward revising specifications is not being directed toward the details that will result in the greater financial gains. Fortunately, opinion plays little part in stating the inadequacy of the conventional procedure, the way in terms of dollars being clearly shown by the statistical approach.

Control Versus Inspection

In the introduction to this series, the reader was advised, "quality cannot be inspected into a product; it must be built in".

In the preparation of specifications this all-too-obvious statement must not be overlooked, as it unfortunately has been much too often. Inspection and production departments each have a specific role in the quality control procedure.

It is still a good rule that along with authority must go responsibility for the actions authorized. The quality of manufactured product is really controlled by the people who run the operations. In contrast, the inspection department's responsibility covers the area of certifying (or not certifying as the case may be) that the required quality has been built in to the product by production. Some specifications can properly be directed to production for control purposes, and others to inspection for certification.

The concept of tolerance originally and primarily seems to have been used to take care of the fact that certain specific and known things would make it "uneconomical" to require all product to come out alike. Recognized were such things as die differences; the complications involved if one charge to a die had to be just like the last; and that temperature changes, lot to lot and drum to drum variations in raw material properties would require "frequent" operator compensating adjustments. But there has been an underlying feeling that, save for these, it would be possible to make all product alike within a "gnat's eyebrow". Many experienced shop people today still believe that. Now and then we even hear instructions to hold a particular lot, for a specific reason, to the high limit or within an amount representing only a small fraction of the tolerance.

A histogram with fine enough cell divisions (to the nearest thousandth of an inch, for example) will show the variation inherent in a process (Fig. 2). A charting technique (keeping measurements in their production order) gives results which can be converted to the process capability (Fig. 3).* This minimum spread of results will apply when the process runs as it did during the collection of the data. Also, this measure recognizes no assignable causes of extra variation as being present. Such causes are those listed in the previous paragraph.

Quality control men call the process capability the natural tolerance of the process, or its six sigma (standard deviation) width. Experience has demonstrated that a good rule of thumb for specification writers is to set limits no closer than eight sigma apart. Thus ample

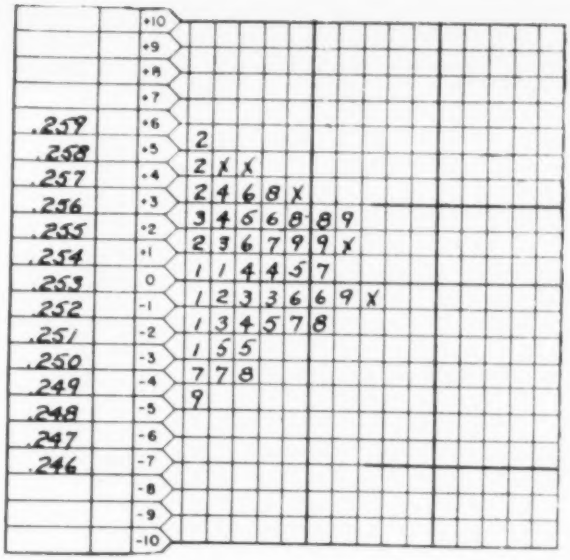


Figure 2. A histogram showing inherent variation in a process. The first five results are marked with a 1, the second five with a 2, and so on.

recognition is given to the economical necessity of living with certain assignable causes.

If the tolerance is one-sided, having just a maximum or only a minimum limit, this point of view calls for at least four sigma between the limit and the desirable or expected average value of the process.

Clearly valuable for specification purposes then would be a list of the process capabilities in a plant. Quite often when the functional requirements of the product seem not to permit eight sigma for the tolerance of a characteristic on one component of an assembly, it is sometimes possible to reduce the tolerance on a mating component (when its sigma turns out to be small enough) to allow the greater tolerance for the part in question.

A few companies have carried this philosophy a step further. Distributions exist of each characteristic of mating ones, or of those that accumulate at assembly to give a possible large build-up. When the peaks or modes of these distributions lie near the center of the tolerance band, the relative frequency or number of parts which occur in the tails of the distributions become fewer as each tolerance limit is approached. So the probability of one of these near-limit parts being selected at random for a given assembly is rather small. But, still more unlikely is the situation where two of these parts near conflicting limits are selected for a single assembly.

The statistical approach readily enables one to compute these probabilities and express a "natural tolerance" of the assembly fit, clearance, or dimensional build-up. The assembly tolerance is made up of the "statistical" sum (as contrasted to the algebraic sum) of the component natural tolerances. As an example, two mating components controlled in production to remain within four units in one case and within three in the other will produce assemblies which will vary five units from minimum to maximum clearance, instead of the seven units as possible variation from an algebraic addition. For three parts, say two, three, and six units, component natural tolerance, the statistical sum will be seven units; a saving of four

(Please turn to page 50)

*The subject of a subsequent article of this series.

PLASTIC PIPE

in the chemical processing industries

B. W. Bender and
J. W. Hawley
U. S. Rubber Co.
Chicago Die Mold Division

ABOVE:
Plastic pipe for ferric chloride treated sewage, aeration lines are piping in rotary filters.

PLASTIC PIPE IS attaining increasingly wider acceptance in all industries utilizing chemical processes because of its superior characteristics in certain applications. The different types of plastics used in piping systems are resistant to a great number of corrosive chemicals, and this can play an important role in reducing the staggering annual cost of corrosion. Being homogeneous, plastic pipe is valuable for piping through highly corrosive atmospheres as well as for conveying corrosive fluids. A second property of major importance is the ability of plastic pipe to handle deionized and demineralized water and sensitive chemical solutions without contamination. Other advantages are light weight, ease of installation, low friction loss and long life.

LIMITATIONS

It must be recognized that plastic pipe has certain limitations which must be considered for successful application in chemical installations. The present plastics are limited to comparatively low temperatures and pressures when compared to other piping materials. Also, while having excellent resistance to many chemicals, the different plastics are attacked by some, and care must be taken to avoid misapplication. More frequent supports are required than with metal pipe. The thermal coefficient of expansion is several times that of metals and must be considered if the system will operate at wide temperature variations.

TYPES AVAILABLE

Proper consideration of these advantages and limitations will result in completely satisfactory piping installations, as evidenced by millions of feet now in service in thousands of plants throughout the country. In addition to the general characteristics of plastic pipe, a proper choice also involves a consideration of the specific properties of the various types available. While there are many manufacturers of plastic pipe and a variety of trade names, there are currently only six basic materials used: polyethylene, cellulose acetate butyrate, vinylidene chloride, polyvinyl chloride, fiberglass reinforced polyester, and styrene acrylonitrile copolymer blends. These materials all have different properties and each has its own advantages and limitations in the form of pipe.

1. Flexible type; Polyethylene
Principal uses include low pressure water service, especially in jet wells and rural domestic water systems, low pressure, low temperature, corrosive solutions and mine drainage. The chief advantages of polyethylene are that it is available in long coiled lengths in the smaller sizes, it is flexible, has high impact strength and is the lowest priced of all plastic pipes. Its most severe limitations are low pressure and temperature range, susceptibility to creep or growth, ease of cutting.

2. Semi-Rigid; Cellulose Acetate Butyrate
The most important uses of butyrate pipe have been in piping natural gas, especially in service entrance lines, crude oil gathering lines, salt water disposal and low pressure water lines. Its chief advantages are low price, high flow factor, ease and economy of installation, transparency. Its principal limitations arise from its semi-rigidity, low pressure, low temperature, its narrow range of chemical resistance, and tendency towards brittleness.

3. Semi-Rigid; Vinylidene Chloride
The oldest plastic pipe was the first to gain acceptance in the handling of corrosive chemicals. Its chief advantage is excellent chemical resistance. Its chief disadvantages are extreme brittleness and very high coefficient of expansion.

4. Rigid; Polyvinyl Chloride
The so-called rigid vinyl pipe is the latest addition to the plastic pipe family. Its principal uses have been handling crude oil and salt water in oil fields where it is making inroads on the business held by butyrate. Rigid vinyl has been used for many years in Europe in the chemical processing industry and is steadily gaining in acceptance in this field in America. It is expected that this growth will continue as more sizes and varieties of fittings become available. There are two general varieties of rigid vinyl pipe. One is made of unplasticized straight PVC compound. This has excellent chemical resistance

but is quite brittle. The other formulation has been modified to provide high impact strength, at the sacrifice however of some chemical resistance.

5. Rigid: **Fiberglass Reinforced Polyester**

Polyester fiberglass pipe was developed largely under Navy development contracts during World War Two. Commercialization has been very slow because of manufacturing problems and product difficulties. Thus it has found only restricted use in salt water disposal and to some extent in corrosion resistant applications. Its chief advantages are that it can be used at high temperature and high pressures. Limitations have centered around the quality of the pipe itself, wet strength especially at elevated temperatures, and difficulties with fittings and connections. As these commercial problems are solved this pipe will undoubtedly show very rapid acceptance in many fields.

6. Rigid: **Styrene Acrylonitrile Copolymer Blends**

Since commercial introduction in 1948 this pipe has been directed very largely to the chemical processing industries. It has, for this reason, found its principal uses in the handling of corrosive chemicals, and in piping solutions which are sensitive to contamination, such as purified water, bleaches and photographic chemicals. Its advantages are its excellent resistance to chemicals, high impact strength and toughness, ability to handle relatively high temperatures and pressures.

Generally, the selection of the best pipe for a given job involves consideration of pressures, temperatures, material to be handled, and the permissible piping layout.

SIZES AND FITTINGS AVAILABLE

In this rapid growth period it is perhaps understandable that standardization has not been fully achieved within the plastics pipe manufacturing industry and that full lines are not always available. A first consideration in specifying a plastic pipe for chemical use is, therefore, the availability of the pipe sizes required and the necessary fittings to make the installation. A second consideration is the ability of the available labor to handle the piping installation and to develop any special skills that may be required. In Table II are shown the available pipe sizes, together with sizes and types of fittings manufactured.

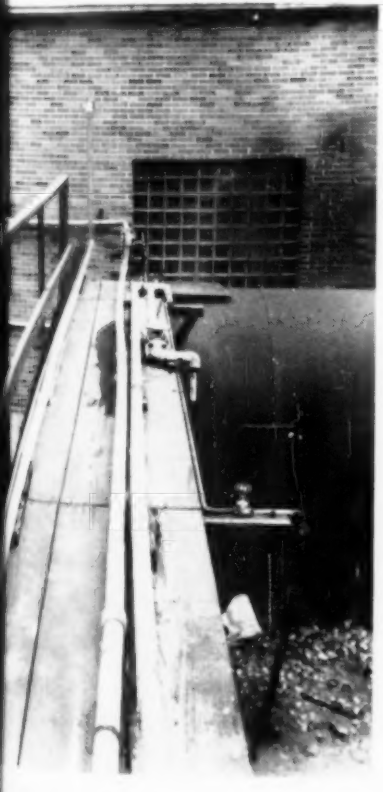
PROPERTIES AND CHEMICAL RESISTANCE OF PLASTIC PIPE

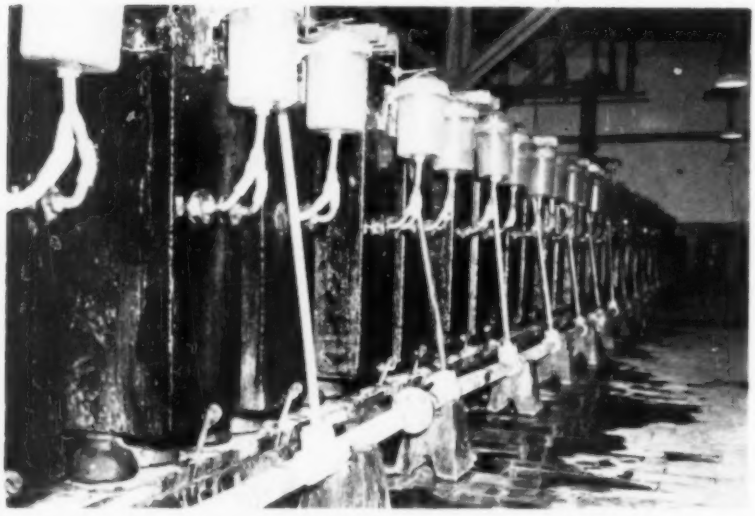
Comparative Properties		Chemical Resistance				
	Max. Temp.	Weak Acids	Strong Acids	Weak Alkalis	Strong Alkalis	Organic Solvents
Polyethylene	120°F	Good	Good	Good	Good	Poor
Cellulose acetate butyrate	140°F	Fair	Poor	Fair	Poor	Poor
Vinylidene chloride	160°F	Good	Good	Good	Good	Fair
Polyvinyl chloride	160°F	Good	Good	Good	Good	Poor
Fiberglass reinforced polyester	230°F	Good	Poor	Fair	Poor	Fair
Styrene acrylonitrile copolymer	170°F	Good	Fair	Good	Good	Poor

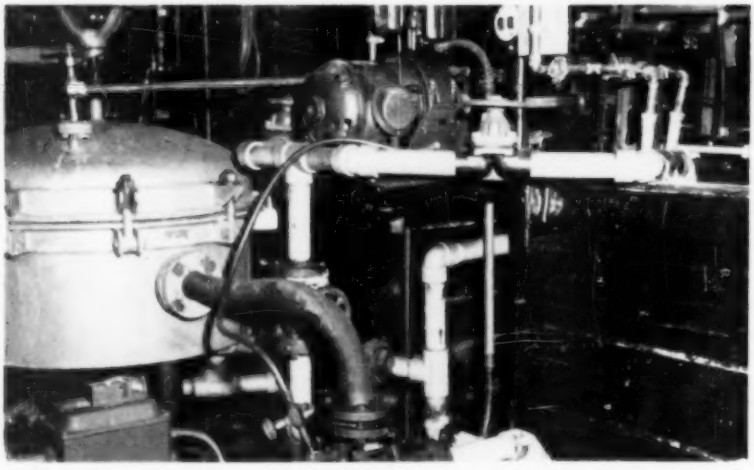
SIZES AND TYPES OF FITTINGS AND METHODS OF JOINING PLASTIC PIPE

Material	Pipe Sizes	Fitting Sizes and Styles		Method of Joining
Polyethylene	½" to 6" IPS	½" to 6" Molded	Insert	Hose Clamps
Cellulose Acetate Butyrate	½" to 6" IPS or SWP	½" to 4" SWP Molded	Slip Sleeve	Solvent Welded
		3" to 6" SWP Fabricated	Slip Sleeve	Solvent Welded
Vinylidene Chloride	½" to 4" IPS	½" to 2" IPS Molded	Threaded	Screwed
Polyvinyl Chloride	½" to 6" IPS or SWP	½" to 2" IPS Molded	Threaded	Screwed
		½" to 6" IPS Fabricated	Threaded	Screwed
		½" to 6" IPS Fabricated	Flanged Slip Sleeve	Bolted Solvent Welded
Polyester Fiberglass	4" to 10" OD Sizes	4" to 10" OD Fabricated	Resin Wrap	Cementing
Styrene Acrylonitrile Copolymer	½" to 6" IPS	½" to 2" Molded	Threaded	Screwed
		3" to 4" Molded	Threaded Flanged	Screwed Bolted
		6" Fabricated	Threaded	Screwed

Plastic Pipe exposed to weather, and conveying chlorine gas and sodium hypochlorite.







These four photos show typical industrial applications of plastic pipe in carrying corrosive materials. (Top to bottom) pipe handles 32% hydrochloric acid; wet chlorine gas; pickling acid; plating solutions.

It is to be noted under pipe sizes that there are two sizing standards, (1) IPS, for iron pipe sizes and (2) SWP, for solvent welded pipe. The IPS sizes are, of course, well known. The SWP sizes refer to a new standard being promulgated by many of the plastics pipe manufacturers for those kinds of plastic pipe which should not be threaded but should be joined by solvent welding. Fittings available do not always match up with pipe size offerings. This is a temporary industry problem that will be solved as more fittings molds are built. In many cases it is necessary, for the present, to use fabricated fittings rather than molded.

In the various kinds of pipe and pipe sizes there are several joining methods. Polyethylene pipe is joined with insert type fittings and hose clamps. This joining method requires no special skill or training. Butyrate pipe is usually offered in SWP sizes with solvent welded slip fittings. Assembly is accomplished by wetting pipe end and fitting-throat with solvent and slipping together. This provides permanent joints which cannot be taken apart. This technique is well suited to long runs of pipe laid by especially trained crews. It does not lend itself too well to installations requiring many fittings especially in close quarters.

Threaded fittings have been most widely accepted for chemical installations. Good joints can be made by men experienced in iron pipe installations with a minimum of special instruction.

Following are some representative applications in which plastic pipe has given completely satisfactory service.

Production of monosodium glutamate and glutamic acid. Pipe handles up to 33% hydrochloric acid, glutamic acid, and monosodium glutamate.

Steel cleaning and plating. Plastic pipe conveys 32% HCL from outdoor storage tank to indoor cleaning and plating tanks.

Uranium extraction. Plastic pipe conveys 10% HCl and 15 H_2SO_4 and slurries containing radioactive salts and fluorides.

Phosphoric acid manufacture. Plastic pipe conveys 75% food-grade phosphoric acid.

Pickling. Plastic pipe used for spray nozzles to wash pickling acid off steel stock. Eliminates external corrosion from acid splash. Also used on tank drain lines.

Bleach manufacture. Plastic pipe conveys chlorine gas and sodium hypochlorite.

Chlorine manufacture. Plastic pipe conveys wet chlorine gas from chlorine cells and brine to the cells.

Hosiery bleaching and dyeing. Plastic pipe handles solution containing acetic acid, oxalic acid, hydrogen peroxide, sulphuric acid and sodium hypochlorite.

Pulp and paper manufacture. Plastic pipe used for conveying alum, brine, brown stock, caustic, chlorinated stock, chlorine gas, chlorine dioxide, hypo, resin size, starch, water, and wet strength resins.

Water Deionizing. Plastic pipe used for conveying deionized water and 20% H_2SO_4 and 22% NaOH used in regeneration of ion exchangers.

Water Demineralizing. Plastic pipe used to convey demineralized water and HCl used in regeneration.

Meat Packing. Plastic pipe handles meat pickling brine.

(Please turn to page 54)

PLASTIC DIES

move into regular production service

George C. Adams
Rezolin, Inc., Los Angeles, Calif.
This paper was presented at the 22nd Annual Meeting of the A.S.T.E., April, 1954

Prior to 1944, experiments had been conducted to determine the feasibility of using plastics for tooling. The result of these experiments indicated that thermosetting phenolic could probably be utilized. It was, however, 1944 before a satisfactory resin was developed. Up to that time, the materials available would shrink, craze and crack. Spurred by the nation's war effort, and the critical shortage existing at that time, considerable effort was expended in the development of the initial tool plastic materials on an accelerated basis. In 1944, a phenolic resin was developed, giving industry for the first time a plastic material that would remain dimensionally stable, a property absolutely required in the making of tools and models.

The acceptance and wide-spread use of this material by the nation's air frame industry is testimony of the material's merit. This industry found that for its needs, the new non-shrink phenolic casting resin saved time and money, and could also be used satisfactorily with a minimum outlay for specialized equipment and highly skilled personnel.

Since its acceptance by the air frame industry, the use of plastic for tooling has spread over the nation and is used today by many industries. The automotive industry at first did not believe that plastics for tooling could be utilized in their manufacturing processes. In recent years, however, they have found that tool plastic materials have many uses and applications in the manufacture of automobiles. Production tools have been successfully used for stamping thousands of parts. Master models, check fixtures and assembly tooling are other prominent usages. The latest development is the use of tool plastic for tooling customized sports cars made with glass fiber plastic laminate bodies.

INDUSTRIAL APPLICATION OF PLASTIC TOOLING

Plastic Draw Dies.—There are many successful plastic draw dies in operation throughout industry. These tools are running in both mechanical and hydraulic presses. The increased speed of the mechanical press apparently does not have a detrimental effect upon their operation. These tools are being used to draw practically all of the grades of sheet steel and aluminum from which drawn sheet metal parts are fabricated. This type of tooling may be manufactured in approximately 20% to 25% of the time span required for conventional metal tools and at about one-third the cost. This decrease in the time span required for tooling a given article, together with the decreased dollar cost, makes it feasible to manufacture many articles which otherwise would probably never be produced in large quantities.

Entirely too many people are prone to think of the automobile industry, the appliance industry, or many other industries, as requiring tooling for millions of parts. This is not correct. In many cases, the required production consists of only a few thousand parts. Over-tooling of these projects, made necessary by a lack of better methods, has imposed a severe economic burden on industry. Properly designed and built, plastic draw dies will economically handle this type of production schedule.

Let us examine the construction of a plastic draw die. Reference to Fig. 1 will indicate that there has been little or no basic change in the overall design of the tool as compared with conventional die construction. There is

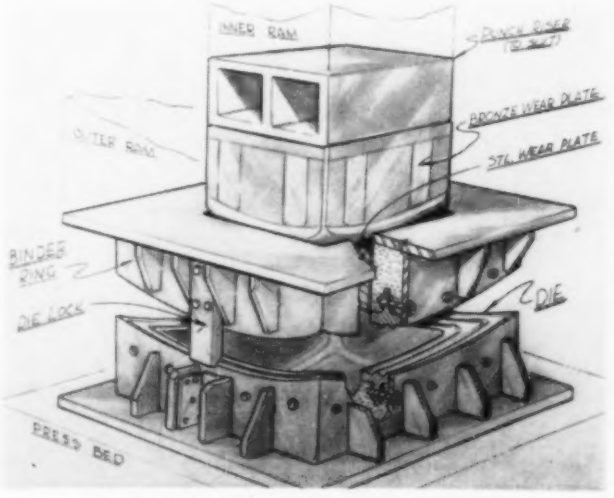


Fig. 1—Typical plastic draw die construction.

a punch, a die, and a binder ring, all mounted in a press just as for any other tool of this type. Plastic components are supported by surrounding metal structures which can be quickly and economically fabricated. The technique used practically eliminates all hand barbering and fitting, and yet the finished tool produces parts which are frequently of superior quality when compared with those produced in the older types of draw dies. If required, cast or laminated epoxy may be used to reinforce the working face of the tool at the points subjected to extreme wear or stress.

Fig. 2—Auto hood produced in plastic draw die.

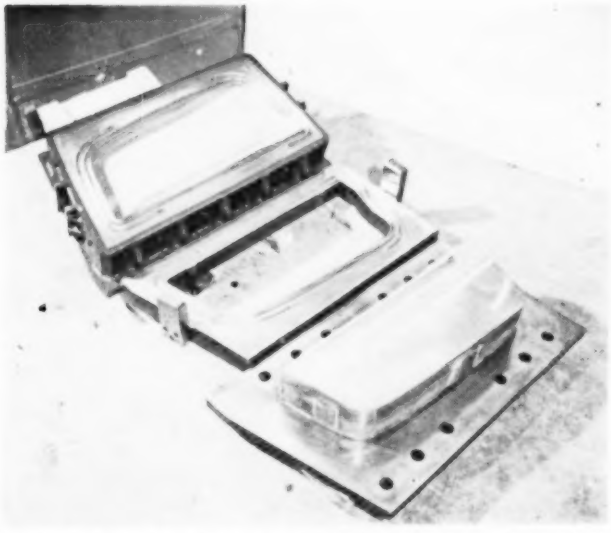


Fig. 3—Fender skirt plastic draw die: (left) the die; (center) the binder ring; (right) the punch.

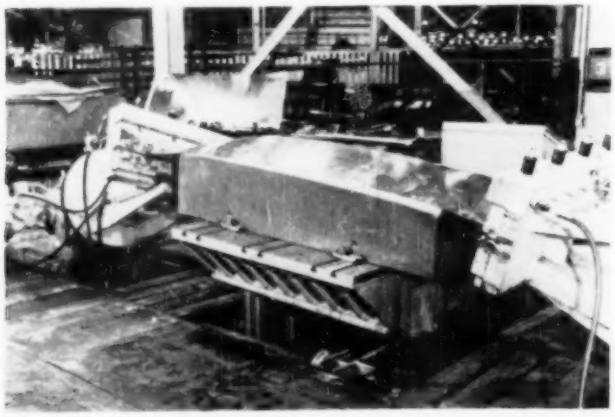


Fig. 4—Plastic stretch die for forming an aircraft assembly part.

Figure 2 shows a plastic draw die in a large Clearing press. This die was used to manufacture the hood of a current model automobile. A number of other components of this same car are being produced in plastic draw dies.

Figure 3 is a fender skirt draw die made of phenolic tool plastic. This tool operates in a mechanical press equipped with a pneumatic cushion. This die has produced over 30,000 parts to date. There are no signs of exceptional wear and maintenance has been negligible.

Plastic draw dies are currently used to manufacture refrigerator outer doors, gas range panels, and special metal cabinets, and many other items. In the aircraft industry, the use of the plastic draw die has become an accepted practice. There are literally hundreds of successful tools in operation drawing not only aluminum, but stainless steel and carbon steel for aircraft components.

Plastic Stretch Dies.—The plastic stretch die is one of the oldest plastic tool applications. It would be difficult to determine the number of tools running in regular production today on stretch presses throughout the country. Practically every make of stretch press is being utilized to operate these tools; to name of few of them, the Hufford, the Sheridan, the Erco, and numerous adaptations of other types of mechanical and hydraulic actuated equipment.

These tools range in size from one having a working face area of 2 sq. ft. up to ones having an area of 140 sq. ft. Particularly in the very large tools, the weight savings (approximately five to one) when compared to metal tools is a very important factor in storage, handling, and the set-up time required.

The glass-like surface that may be obtained eliminates practically all of the galding or other die marks that frequently appear on the parts made with metal stretch dies.

Figure 4 is a stretch die in operation in a Sheridan press. This particular tool was built in 1948 and has worked through four separate model changes in an aircraft program. Since it produces a part which is used in an aircraft assembly that requires frequent replacement, a comparatively high total production has been obtained from it. Yet, today there is no sign of exceptional wear on this tool.

Figure 5 is a cross-sectional drawing of the construction of a stretch die. Note the metal base, the foam phenolic core and the solid phenolic working face. This type of tooling may be produced in a minimum of man-hours and consequently at a very low dollar cost.

Stretch dies are used in the manufacture of refrigerator components and panels for certain types of large automotive vehicles such as buses. The aircraft industry is the largest single user of stretch dies.

Drop Hammer Dies.—The tool plastics used in the manufacture of drop hammer dies are special patented formulations of castable ethyl cellulose. This material being a thermoplastic, is readily melted, utilizing special equipment designed for that purpose. It can be cast in simple molds to the required shape. It is reclaimable. Therefore, after the tool is retired from service, it may be melted down and reprocessed for use in new tooling.

Figure 6 illustrates typical drop hammer dies. Note in these particular tools that the die or cavity portion of the tool is made of metal. The punch is made of tool plastic. The tool plastic punch is considerably softer than the metal die and possesses resiliency and elastic recovery approaching that found in rubber. This enables the tool

builder to eliminate the metal thickness clearance between the punch and the die. The tool plastic material will compress sufficiently to permit the running of a rather wide range of gauges of metal in the same tool without alteration. This method of tooling also produces the required stamping with a minimum of variation in cross section thickness.

Another type of drop hammer tool is illustrated in Figure 7. In this tool, the die cavity is made of ethyl cellulose tool plastic and is contained in a steel weldment. The punch is also made of tool plastic. The core or body of it is a phenolic tool plastic cast. The working face is an epoxy laminate. The entire punch is contained in a steel weldment.

The advantages of this type tool are: (1) The configuration may be obtained by using simple plaster patterns to make the required punch mold. After the punch has been completed, it is inverted. The weldment, which will contain the die cavity, is placed above it in closed die position. This permits the die to cast directly against the punch from the bottom of the tool, thereby eliminating practically all barbering and assuring the tool builder of a proper mate between the two halves of the tool. (2) By eliminating the hand barbering of the die cavity, a major portion of the tool cost is avoided. (3) This type of drop hammer tooling does not require metal clearance between the punch and die.

In another type of drop hammer tool, the die cavity is made of a phenolic tool plastic core capped with an epoxy laminated working face, all of which is contained in a steel weldment. The punch is made of ethyl cellulose tool plastic and does not require any type of metal reinforcement. No metal clearance is needed between the punch and die.

Figure 8 illustrates still another type of drop hammer tooling. In this tool, note that the die cavity is made of metal. The punch is made of a metal core, faced with castable epoxy. Surrounding the punch is a movable thermoplastic ring. This ring is similar in principle to the conventional double-action draw die binder ring. Since this ring is made to float freely up and down the punch within the required limits, it must be retained on the punch by the cross rods shown in the picture. It is actuated by an external source of force. This force is obtained by placing layers of rubber between the ring and the hammer head. When the hammer strikes, the punch is forced down, and the ring compressing the rubber above it moves upward. This action clamps the metal blank between a portion of the die face and the ring, but permits the punch to force the remaining metal into the die cavity, thereby obtaining a true drawing action in a drop hammer. By removing the layers of rubber that are between the tool plastic ring and the hammer head, one layer at a time, a progressive-stage drawing process is obtained. In general, the depth of draw is limited only by the properties of the metal blank. Further economies may be effected by making the die cavity of plastic using the technique previously described. This tool plastic application will be of considerable value to the industries, such as aircraft, who utilize the drop hammer as a production tool. The automotive industry, during some of its early development work, should also find considerable use for this method of metal forming.

Laminating Molds.—The manufacture of plastic laminated structures such as automobile bodies, small boats, and aircraft radomes are outstanding examples of how plastic tooling can aid industry.

Let us consider the recent manufacture in the

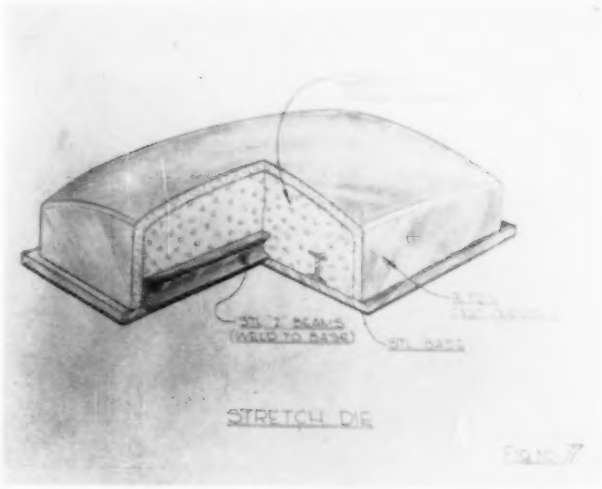


Fig. 5—Cross section of representative plastic stretch die.

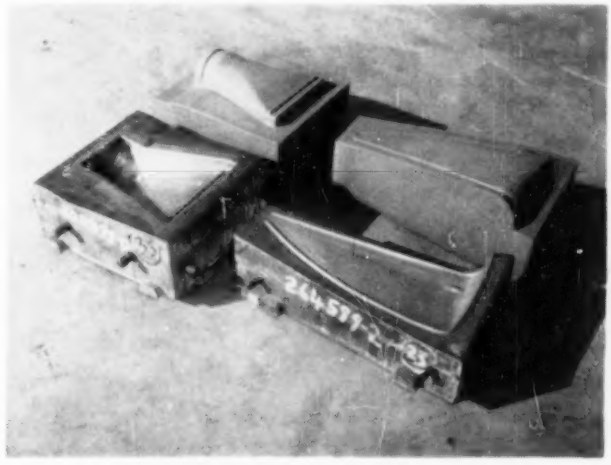


Fig. 6—Typical drop hammer die with plastic punch.

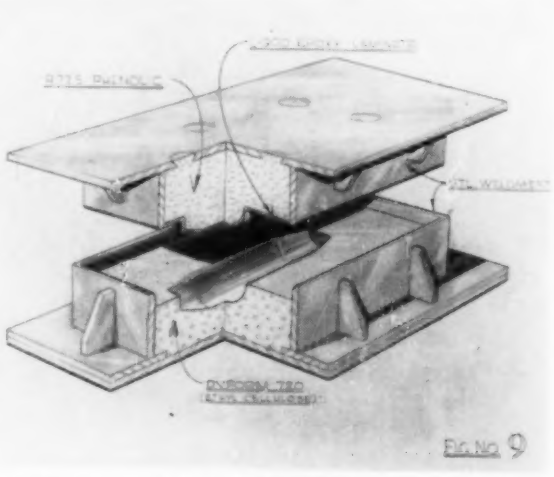


Fig. 7—Drop hammer die with plastic die cavity and punch.

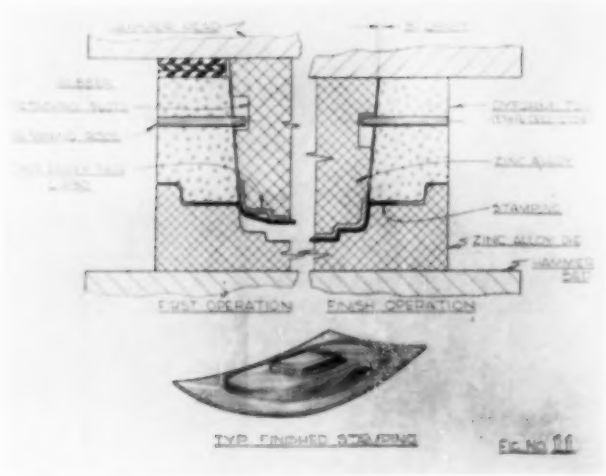


Fig. 8—Drop hammer die: metal-core punch is faced with plastic; die cavity is metal.

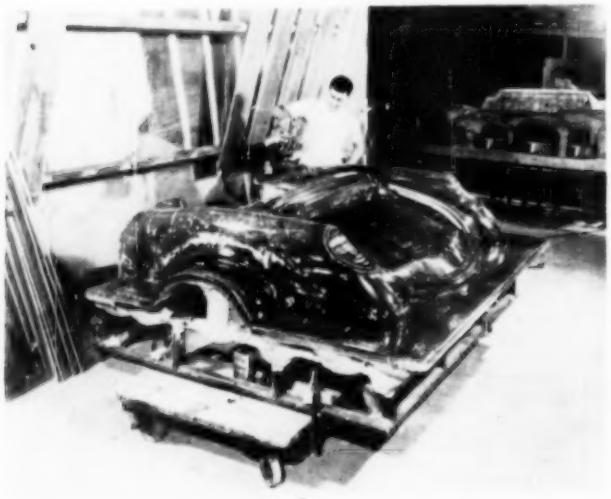


Fig. 9—Plaster mold developed from master models, for producing a plastic auto body.

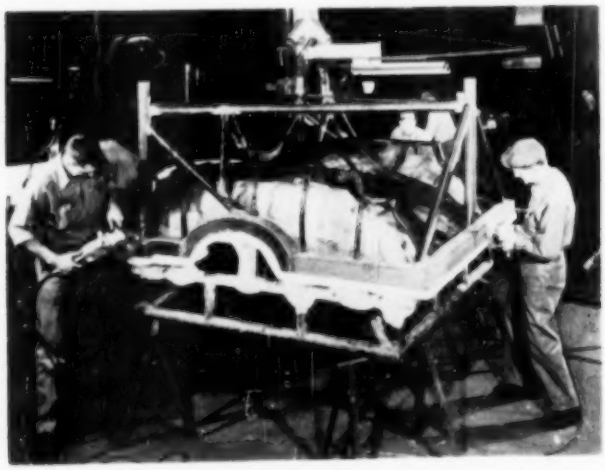


Fig. 10—Welded metal structure for supporting the mold of Fig. 9, and for raising it to working height.

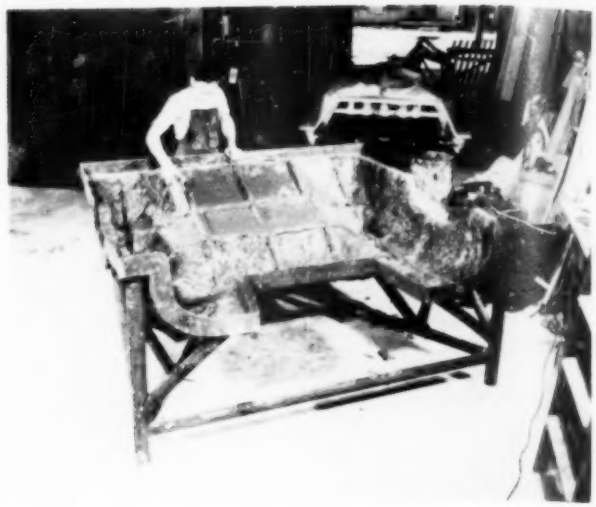


Fig. 11—Putty coat layer of plastic being troweled into the metal structure on Fig. 10.

United States of the first production sports car with a plastic body. The initial tooling of this car was almost entirely made of tool plastic. This fact enabled the manufacturer to put the car on the road months ahead of the best possible date that could have been obtained with conventional metal tools. The cost was approximately one-fourth that of metal tooling.

Fig. 9 shows the plaster mold which was developed from the master models. In the illustration, the mold is being treated with the required surface finish and parting agents.

In Fig. 10 is seen the metal supporting structure which will serve the dual purpose of supporting the mold and raising it to working height. This structure is a weldment made up of structural angles and steel tubing. The large area is filled in with expanded metal lathe.

Figure 11 illustrates the application of the putty coat layer of tool plastic. This material is troweled into the expanded metal lathe. When the putty coat has cured, it will form a continuous backing to which the working face of the laminating mold will bond, thereby assuring the tool builder of a rugged, stable mold.

In the actual casting of the tool, the plaster mold shown in Fig. 9 and the metal supporting frame with its

Fig. 12—Final finishing of laminating mold, of which construction stages are shown in Figs. 9, 10 and 11.

putty coat layer in place (Fig. 11), are mated, and tied together with plaster and hemp. The mold is cast using conventional metal casting techniques, i.e., with a pouring gate and risers which permit the included air to escape.

Figure 12 shows the final finishing of the completed tool. After it has been separated from its mold, about all that is required is to remove the flash and to buff out the surface. Thus, a very complicated laminating mold is produced in a minimum of time. Practically all hand barbering has been eliminated.

The completed underbody mold for this same car is also made by this method. This is one of the largest commercial laminating molds built to date.

The completed front end mold for the same car was produced by the same construction and manufacturing principles as were used in making all of these tools.

In order that the product designer may take full advantage of the possibilities inherent in making large and complicated parts of laminated plastic materials, a relatively large and complicated mold is frequently required. Normally, this practice would create an expensive tooling program of unusually long duration. By utilizing tool plastic, however, the tooling time spent can be reduced and the dollar cost of the tools brought down to an economic level that permits a manufacturer to take full advantage of the design possibilities of laminated parts. This type of tooling has proved successful in the manufacture of the automobile body previously referred to—so much so, that duplicate tooling has been constructed in order to increase the production of the automobile. No major changes were made in the design or manufacture of these duplicate tools.

Post-Forming Dies.—The post-forming of thermoplastic sheeting such as Styron, Royalite or similar materials has become a major production method. Tool plastic makes possible the economical manufacture of dies for this work.

Figure 13 shows the tooling and equipment required to make a refrigerator door liner. It consists of a movable heating unit mounted on a track, a stationary tool plastic post-forming die, and a movable clamping frame which is mechanically actuated. A sheet of material is hand-loaded in the clamping frame and clamped in place. The heating unit is moved into the proper position and the sheet is heated. The hot material is then drawn into a locked position over the die by the mechanically-operated clamping frame, thereby forming an airtight seal between the sheet of plastic material and the die. The air between the die and the hot plastic sheet is exhausted. Vacuum pressure so applied forces the hot material into the required configuration. A strong blast of cold air chills it, thereby completing the forming of the desired part.

Figure 14 shows refrigerator door liners made on this type of tooling and equipment.

Plastic tooling may be utilized in the manufacture of many post-formed products from practically all of the thermoplastic materials fabricated by this process. Mated punches and dies are sometimes used for this purpose. In designing and building these tools, the same general techniques previously described are used.

WHAT ABOUT PLASTIC TOOLING OF THE FUTURE?

Although the plastic tooling industry of today is able to offer manufacturers of sheet metal and laminated plastic products substantial savings in time and money, these economic advantages should be more obvious in the future. This will probably be accomplished in a large measure by utilizing the right combinations of the various tool plastic materials available, in much the same

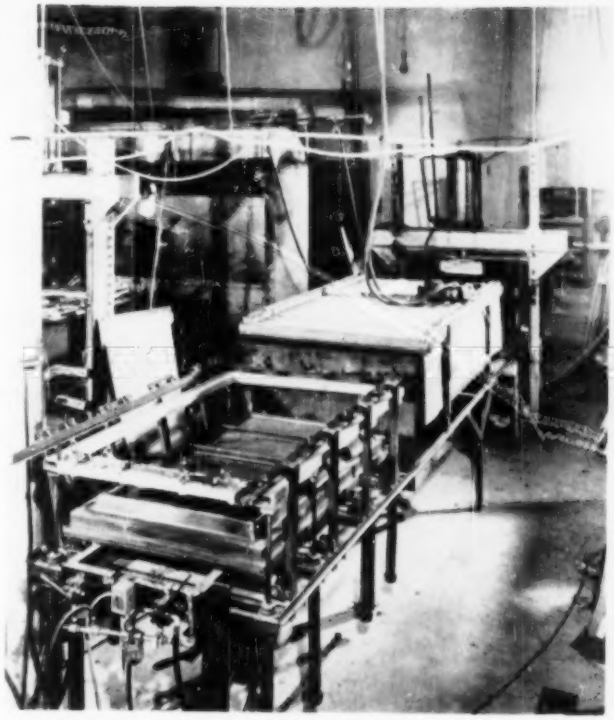


Fig. 13—Tooling and equipment for post-forming a refrigerator door liner.

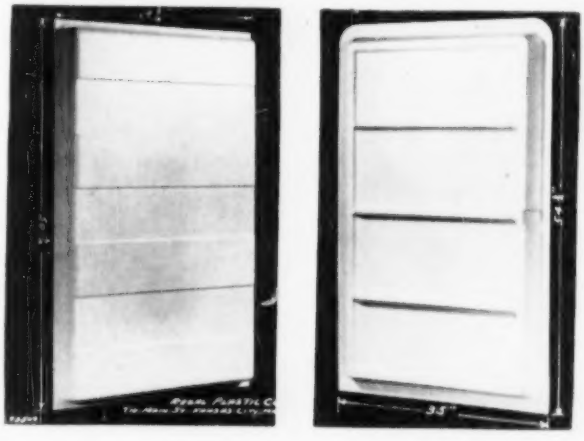


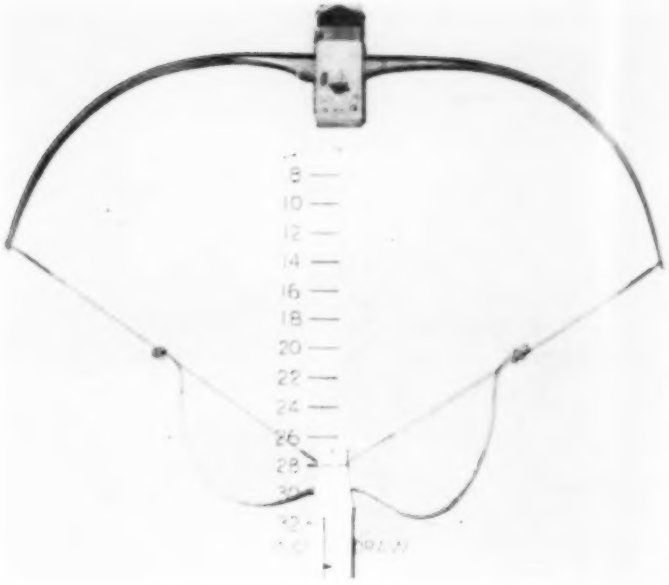
Fig. 14—Post-formed refrigerator door liners.

manner that the builder of conventional metal tools uses the various types and grades of steel. We have the relatively low-priced phenolic materials which can be used for making the large casts that will be required. These phenolic casts can be reinforced at points of extreme wear or stress by using either cast or laminated epoxy to increase the tool life, to reduce the required machining, and to make the tool less susceptible to damage in storage. We also have the high-impact thermoplastic materials which may be used alone or in conjunction with other types of tool plastic. This will enable us to manufacture tooling capable of withstanding all of the impact forces to which it is reasonable to expect properly handled tools will be subjected.

As the economic pressures normally expected under our competitive system are applied to all industry, the advantages of the relatively low-cost and quickly obtain-

(Please turn to page 51)

a sporting approach to strong plastics



James W. Case

HOW STRONG IS STRONG? Let us temporarily lay aside modern methods of measuring the strength of plastics and go back to times when man knew the strength of materials only by their resistance to the forces that he applied to them by the strength of his own hands.

A good subject for study is the archery bow, which early man used for killing game and his enemies. This former weapon has now become a widely popular sporting and recreation item and in it we have an example of materials development that, if studied carefully, will give us a new starting point in the improvement of reinforced plastics.

The cave man who probably first constructed a crude bow from a bent tree limb and a rawhide string was depending upon the fibers of the wood to stretch and return to their original shape when the arrow was released. Through the ages, the performance of this crude weapon was improved by the use of tougher and more elastic woods and by the careful selection and utilization of special fibers for tension and compression in the composite structure, thereby pre-dating our reinforced plastics by several thousand years.

Fortunately, authentic examples of these early "laminates" are in existence today. The principle of strong fibers in tension for high flexural strength was put to excellent use by Egyptians (1), whose composite bows of wood and sinew had a far better basic structure than many bows used in modern archery. It is certainly noteworthy that this useful and highly efficient weapon was powered by a backing of specially treated sinew, glued onto the wood in a pre-stressed, parallel arrangement. Thus did our predecessors employ the basic principles of a beam in flexure several thousand years before laws on the strength of materials were developed.

In more recent times, the Turks improved upon the Egyptian bow and set distance shooting records which have remained unbeaten to this day. Just how this was accomplished can be, in a measure, understood through research by Klopsteg (2) which brings out that the Turkish bow makers spent years to make a bow, alternately heating and normalizing the wood core to which they glued a backing of special ox sinew for tension forces and a facing of horn for compression. This bow was short of limb, very strong and when unstrung, took a reverse bow shape in the form of a "C", all of which points to a highly stressed, elastic structure and efficient utilization of fibers in tension.

The distance shooting record of the Turks, (about 900 yards) are certainly a challenge to present day archers. Only until recently has their record passed the 600 yard mark and this can be attributed to the efforts of American archers to re-discover a lost art through the use of elastic glass fibers, and now, instead of being used directly in a weapon of war, as with the Egyptian bow, the beautiful qualities of this material are contributing to a fast growing sport in America, at the same time, continual development by bow makers to get the utmost in performance from glass fiber powered bows has lent inspiration and new engineering thinking to the perfection of a new structural material—parallel glass reinforced plastics, which may not be in itself a weapon, but can be used in weapons applications to advantage.

Head, Materials Section, Plastics, Preservation and Materials Handling Branch, Bureau of Ordnance, Department of the Navy.

Now we come to the point of common interest between archery bows and high strength plastics — high flexinal strength — and let it be said here that the reinforcing fibers of glass are the load bearing elements upon which we must depend for high strength properties.

Today in reinforced plastics circles we hear a lot said about ultimate strength and modulus of elasticity. Such figures as 300,000 psi ultimate and 10,000,000 modulus, advertised for glass fibers, are widely accepted while we, at the same time, accept much lower values for the laminates which are made with these fibers. Should we not, for the time being, find out how to make a glass-plastic laminate which will take on extreme bend and high stress again and again without breaking, like that of a good bow, the better to understand the performance of glass fibers and plastics under stress?

Figure 1 shows a glass-plastic laminated bow under test. This setup is an excellent medium for working out a great many of the problems that beset laminators of glass reinforced plastics. At the full draw point, the glass reinforcing fibers of the bent bow limbs are in a state of high stress and elongation. This develops great shearing forces between the laminating resin and the glass fiber, requiring the best of materials and fabrication methods for success. By means of the weight scale, a force-draw curve on the bow can be taken to show the load-flexure characteristic of the full size members. By taking the difference between the unloading and loading curves, the "hysteresis" or tendency to take a set is quite easily shown up. Additional light on the elastic quality of the reinforcing fibers is developed by removing the bow from this test and placing it back on its original fabrication form, where any failure to return to original shape may indicate cold flow of glass or resin, delamination, uneven stress on the fibers, and the like. Finally, if the bow stands up well under these tests, we can take it out on the range and watch and feel the action of the limbs in snapping out the arrows. Later we go on an actual hunt in the woods, with our arrows tipped with steel broadheads. Our bow is strung up from early morning to late evening plus some game shots at full draw. If the bow limbs return to their original shape when the bow is unstrung at the end of the day and no failures are indicated we can feel that we have learned a lot about making strong plastics!

Very certainly, neither the Egyptians nor the Turks knew anything about classic values of strength or modulus. Their object was to **shoot arrows.** Selected fibers located at the highly stressed sections of their weapons did the trick, which was to provide the necessary energy storage capacity, again and again without failure or diminution.

The bow of the Egyptians was recurved (bent backward) about 30° from a straight line (when unstrung), quite obviously putting the working stress of the sinew backing well up on the load-deformation curve at the start of the draw. While this bow was used for hunting and for war, the bow of the Turks was used only for distance shooting and must have been shot by a race of very strong men. Their weapon was recurved far backward from a straight line with backings of parallel layed sinew from the hind legs of a special breed of a bull.

According to the apparent construction of these weapons, it is reasonable to assume that the materials from which they were made were characterized by **low ultimate strength, low modulus** and **high elongation.** We might expect that built up sections of these materials would necessarily have been quite thick and heavy, but this is not true. In fact, both the Egyptian and Turkish bows were smaller at their working sections than numerous modern composite bows of wood or plastic and glass. Indeed, the lost art of archery bow making is more truly a lost art of making composite structures (laminates) of strong, elastic fibers and binders (resins).

Now having recognized the close relationship between laminated bows, ancient and modern and synthetic structures of reinforcing fibers and plastics, let us set up some of the important essentials by which bow laminates should be made and at the same time establish some of the essentials of high strength plastics.

Returning to our original question concerning strength, two other mechanical characteristics, elasticity and toughness, appear to be highly important in a bow section or in laminates for engineering applications. In simple language, "strength, flexibility and toughness" are of first importance.

STRENGTH

For high strength in bending, the composite structure should have strong, reinforcing fibers so positioned that they will lend their physical characteristics to the composite structure itself. These fibers are then the load bearing elements and must be oriented parallel to the long axis of the laminate. Quite obviously, the fibers must not be "bunched," slacked, or looped with respect to each other, that is, they must be layed to be stressed in unison. This requirement not only precludes the use of any fibers in the form of woven fabric, but also so-called "uni-directional" reinforcement such as roving or yarn that is made up of

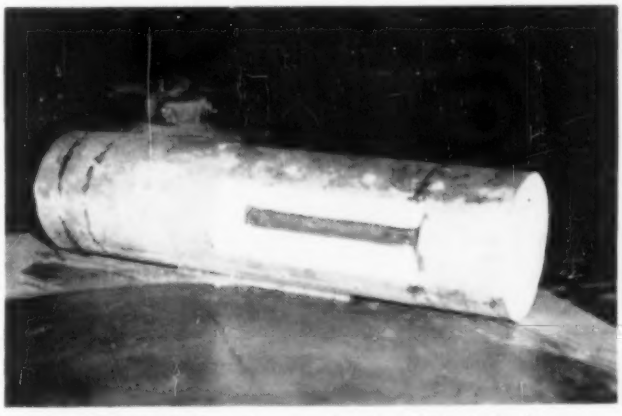


Figure 2. Gas fired glass furnace, showing 100 hole bushing.

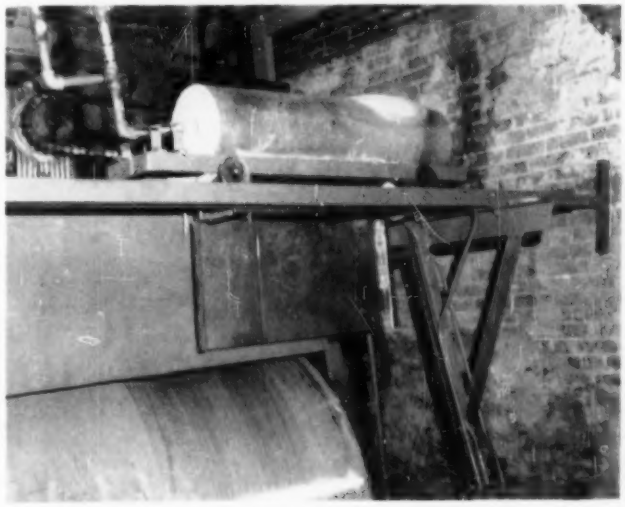


Figure 3. Front view of glass fiber forming equipment, showing the furnace on traversing track, back plate of the Magic Box and fiber collecting drum.

multiple strands of twisted fibers. Let it be said again that this is not a new doctrine, for we are only re-employing the ancient art of the bow makers.

While we must now again give credit to American industry for the improvement, in recent years, to archery bows with glass fiber, the ideal equal loading of glass filaments (in bows or reinforced plastics) has been accomplished apparently only to a degree, because of dependence upon commercial glass fiber yarn. This is made up of several strands of glass, each being two hundred or more filaments, thereby having a somewhat twisted and unequalized fiber geometry due to the textile operations involved. The significance of individual glass fiber loading will be fully treated in a later section of this paper. (See "Discussion of Glass Fiber")

FLEXIBILITY OR ELASTICITY

It is quite well known that most all materials deform to a certain degree when subjected to stress. With a bow, we want the built up section to take on extreme bend and impart the stored up energy to the arrow shaft. We desire also that the bow will have the same strength on the next and succeeding shots. As the archers say, "It should not let down or follow the string." In more technical language, we want the flexed member to follow a straight line load-deformation curve below an elastic limit* which we are careful not to exceed in service use. As applied to complete items of reinforced plastics which are subjected to dead loads or impact in service, we want performance that is dependent upon the same principle. For example, shipping and storage containers, which are being actively investigated in reinforced plastics, are piled one on another and receive high impact abuse in service. Quite obviously, no success can be expected from these developments if the laminated structure from which they are made will not return to its original shape after the load is removed.

TOUGHNESS OR MECHANICAL DURABILITY

If our bow is to retain its high strength and elasticity over a long period of time, it should obviously be held together with strong binders (plastic resins) which will withstand rough service use. Then it follows that the working reinforcing fibers must be held together in a permanent working relation with each other. Actually, we mean that the fiber-to-resin-to-fiber bond system must be high, that is, there must be high "inter-ply strength."

It appears that this feature in a reinforced plastic laminate is contributed not only by the resin itself but by the actual degree of bond between the fiber and the resin. This quite apparent weakness of present day plastic laminates is easily demonstrated by use of a jacknife with a blade that need not be sharp. Starting at the edge of the laminate, the blade is worked between the plies of fibers and the delamination thus started is quite easily continued across the sheet to split it in two. If we use the same tool and examine some of the hardwoods such as oak, birch or maple, the impression remains that the natural bond between the parallel fibers of these materials is superior to the inter-ply bond of reinforced plastics.

Therefore, in both archery bow structures and laminated plastics we strive for toughness by use of the best resins obtainable and employ laminating techniques to improve the glass-resin bond.

* *The point on a load-deformation characteristic at which stress ceases to be proportional to deformation and beyond which a plastic laminate is damaged by breakage of fibers, or delamination, or both.*

DISCUSSION ON GLASS FIBER

The predominate use of glass fiber in the reinforced plastics industry leads us at once to select this material for further discussion and investigation. This material is being used for plastics reinforcement in many forms from short chopped mat to woven fabric, however, this use does not take advantage of the many fine characteristics of glass fibers which are covered in available literature. The Owens-Corning Fiberglas Corporation (3) states that: "Since the structural characteristics of plastic items are determined partly by the individual properties of the resins or binding material and, to a greater extent, by the properties of the reinforcing mediums, the judicious use of Fiberglas will increase the utilization of plastic materials by compensating for lack of stiffness, toughness, ductility and dimensional stability under varying conditions." This same authority represents glass fiber as having 300,000 psi ultimate tensile strength and 3% elongation. No doubt this information is based upon the work of Andregg (4) who states that: "A large number of fibers were loaded step-wise and elongation carefully measured. In every instance after loading (even up to 2/3 of the breaking load) and releasing, the pointer returned to its original position as closely as could be read. In no single instance—was any evidence developed of plastic flow in the glass. Stress-strain curves were all perfectly straight, as far as methods used would indicate." We are therefore justified in pursuing methods for full utilization of the elastic constants of glass fibers in multiple filament structures.

Other investigators have noted the difficulties of attaining equal tension on the fibers of conventional glass roving or yarn, where these materials are tested in laminates.

Bainton, Guare and Mathes (5) in the introduction to their investigation on the hysteresis of glass fiber reinforced plastic rods in cyclic loading, state that: "Glass-fiber reinforced plastics possess high tensile and bending strength only if the glass fiber rather than the resin is stressed. The resin serves to bind the structure together and to transfer mechanical stress from one fiber bundle to another." These workers were quite aware of the importance of equalizing the stress between glass fibers in a laminate. Their rod test samples were made of 20-end "even tension" glass rovings, totaling 40,800 fibers per rod. In their flexure tests on these rods, they experienced a "meadering" of the stress-strain curve which was attributed to the unequal distribution of ends in the sample and progressive loading and breakage of the individual fibers as the load on the sample increased. These authors then conclude that: "Even though every effort was made to attain even tension on the glass, it is apparent from the results that real uniformity was not attained and cannot be attained in practical structures."

The observation of Bainton, Guare and Mathes regarding the unequal loading of glass fibers in twisted ends is in agreement with that of Hindman and Burr (6), who publish the results of their tension rupture test on glass roving. They state that, "In this case this technique showed the early nonlinearity as the fibers in the yarn were aligning themselves during the initial application of the load." Their graph also indicates that, after equalization of the load between the fibers, straight line proportionality existed on the sample to a sharp rupture point.

More recently, the author of this paper initiated tensile tests on single glass fiber filaments, using new equipment which has lately become available for testing at loads of a few grams. A typical graph from these tests indi-

(Please turn to page 32)

Introducing...

Melmac® 3135

A new and improved melamine-glass high-impact material with exceptional molding and electrical properties

New melamine-glass material above, original compound below. Note reduced bulk factor.

MELMAC Molding Material 3135, a product of Cyanamid's continuing program of product development, offers you for the first time an impact material that is readily moldable, with exceptionally high arc and flame resistance.

MELMAC 3135 can be compression- or transfer-molded – in small or large parts – with equal facility. It flows so well that even intricate and thin-sectioned parts can be molded without "shorts." And it can be preformed and preheated.

MELMAC 3135 meets all requirements of MMI-30, MIL-P-14 – is ideal for heavy duty electrical application including switch gear or circuit breakers, sockets, terminal blocks and strips, coil forms, stand-off insulators and connectors.

Here are just a few of the important, distinctive properties you get in MELMAC 3135:

Impact strength (ASTM)	4.0-6.0 Ft. Lb./in (Izod)
Arc resistance (ASTM)	183-186 Seconds
Flame resistance (ASTM)	Excellent (self-extinguishing)
Heat distortion point (ASTM)	400°F
Dimensional stability	Excellent

AMERICAN Cyanamid COMPANY

PLASTICS & RESINS DIVISION

32D Rockefeller Plaza, New York 20, N. Y.

In Canada: North American Cyanamid Limited, Toronto & Montreal

MAIL THIS COUPON—FOR ADDITIONAL TECHNICAL INFORMATION

— including properties, test data, information on molding, shrinkage range, preforming and preheating, storage and handling, finishing.

AMERICAN CYANAMID COMPANY, PLASTICS AND RESINS DIVISION
32D Rockefeller Plaza, New York 20, N. Y.

Gentlemen: *Please send me complete technical data on MELMAC 3135.*

Name _____ Title _____

Address _____

Company _____

City _____ Zone ____ State _____

Program For The Eleventh Annu

WEDNESDAY, JANUARY 19

Registration — Lounge Floor; begins at 9:00 A.M. and continues until noon Friday.

11:00 A.M. Press Representatives — reception in the Najavo Room, 15th floor.

12:00 Noon Past President's Luncheon — the Wedgewood Room, Lounge Floor.

1:00 P.M. Opening Ceremonies — Welcome by A. J. Kissileff, general chairman — The National Anthem — Invocation by Rev. Richard F. Gornet — **"Growth Through Engineering,"** address by John Labelle, National President SPE. Vernon Room, Lounge Floor.

A

WEDNESDAY, JANUARY 19, 1:30 P.M.

Session A—Vernon Room

FLUOROCARBON PANEL

Moderator—George Koch, Oak Engineering Co.

Properties and Characteristics of Kel-F—Jules Jupa; M. W. Kellogg Co.

Molding & Fabricating Kel-F, and Fluorothene—William Campbell; U. S. Gasket Co.

Molding Teflon—C. M. Hobson; U. S. Gasket Co.

Fluorolubes, Lower Molecular Weight Polymers of Chlorotrifluoroethylene—L. S. Bovier with C. I. Gochenour, E. A. Belmore, and C. F. Baranauckas; Hooker Electrochemical Co.

Physical Properties of Teflon Tetrafluoroethylene Resin—R. C. Doban, with C. Sperati, and B. W. Sandt; E. I. DuPont de Nemours & Co.

B

Session B—Rutland Room

Moderator—A. Lightbody, Naval Ordnance Lab.

Quality Control—Warren Purcell; Rath & Strong

International Standards Organization—Robert Burns; Bell Telephone Laboratory

Feasibility of Reinforced Concrete with Pre-Stressed Tension Members—Admiral M. Angas, USNR; Princeton University

Significance of Heat Distortion in Uses for Acrylic Resins—J. J. Gouza; Rohm & Haas Co.

Selection of Plastics for Refrigerators—William Gobelle; American Motorcar Co.

THURSDAY, JANUARY 20, 8:45 A.M. **Invocation** by Rabbi Harry Jolt

Moderator—G. W. Martin, Noma Lites, Inc.

Reinforcement of Silicone Rubber with Teflon—G. S. Irby; General Electric Co.

Compounding Polyvinyl Chloride Using Powder-Mix Technique—A. M. Medoro; Auburn Button Works, Inc.

Dry Blending Compounding of Polyvinyl Chloride Resins—O. L. Law, and W. Q. Gordon; Goodyear Tire & Rubber Co.

Laminates for Printed Circuits—Norman Skow; Synthane Corp.

Asbestos Reinforced Plastic Manufacturing & Design Techniques—William Braham; Zenith Plastics Co.

CONTROLS PANEL

Moderator—Saul Blitz, Tico Plastics, Inc.

General Principles of Mold Temperature Control—Paul A. West; Sterling, Inc.

Temperature Control with Mold Design—C. H. Whitlock; Whitlock Associates

Mold Temperature Control From Viewpoint of Material Supplier—Gordon Thayer; Dow Chemical Co.

Instrumentation Keeps Pace with Plastics Development—R. A. Schoenfeld; Wheelco Instruments, Div. of Barber-Colman Co.

Plastic Pipe—Wes Larson; DeBell & Richardson

12:30 ANNUAL BUSINESS LUNCHEON — Announcement of Election Results—New Officers—Wedgewood

THURSDAY, JANUARY 20, 1:30 P.M.

Moderator—R. H. Bruce, Bakelite Co.

Compounding & Processing Co-polymer Styrene Resins For Manufacture of Tough Rigid Plastics—K. K. Fligor, and R. J. McCutcheon; Goodyear Tire & Rubber Co.

(Continued on Page 30)

Moderator—Islyn Thomas, Thomas Engineering Co.

Engineering of Mold Design—Wayne Pribble; Pribble Plastics Products, Inc.

Plastics For Aircraft Tooling—Benjamin Sokol; Republic Aviation Co.

(Continued on Page 30)

PE Technical Conference . . . . .

—Wednesday, January 19 Through Friday, January 21, 1955—

"Growth - Through Engineering"

C

Session C—Viking Theatre

Moderator—M. J. Petretti, Camfield Fiberglas Plastics.

Plastics in **Atomic Energy**—Oscar Sisman; Oak Ridge Nat'l. Laboratory

Mold **Erosion Using Radioactive Tracer Technique**—A. P. Landall; General Electric Co.

Molding **Granulated Wood**—K. H. Brockschmidt; Plastics Engineering Co.

Fast Cycle Injection Molding of Low-Cost Fibre-Filled Compounds—Alde Simmons; Plymouth Ind. Products Co.

Paper-Plastics Combinations—Dr. V. T. Stannett, and E. C. Jahn; New York University

EDUCATION PANEL

Moderator—Richard B. Bishop, Foster-Grant Co.

Report **of Technical Advisory Committee SPE**—W. O. Bracken; Hercules Powder Co.

Application **of the Principles of the Plastics Industry**—E. F. Schumacher; Polychemicals Department; E. I. DuPont Co.

Trends **in the Plastics Industry**—H. Zabel; Roger Williams Technical and Economic Service

What **the Plastics Engineer Can Do for Your Company**—Prof. Louis Rahm; Princeton University

Report **of the Education Committee SPE**—Prof. Jules Lindau, III; University of S. Carolina

Moderator—Stanley Bindman, Jamison Plastics Co.

An **Evaluation of Dry Offset As A Method of Decorating**—David Putnam; Markem Machine Co.

Color **Paint and Plastic**—Lloyd E. Parks; Logo, Inc.; (2) Periods

(Continued at bottom of Page 30)

Ladies Program

WEDNESDAY, JANUARY 19, 10:00 A.M.

Get Acquainted Coffee Hour—Sunporch Lounge

WEDNESDAY, JANUARY 19, 12:30 P.M.

Ladies Luncheon—Carolina Room—Greetings—Mr. Mal Dodson, Publicity Bureau of Atlantic City

WEDNESDAY, JANUARY 19, 2:00 P.M.

Hat Show—"Grandma Buys A Hat"'—Door Prize—A Hat Worth $25.00

WEDNESDAY, JANUARY 19, 3:00 P.M.

Boardwalk—Shopping—Films

THURSDAY, JANUARY 20, 9:30 A.M.

Coffee Get-Together—Stair Hall Lounge Floor—Tour of Lenox China Factory, Pomona, New Jersey; via Chartered Bus; 1½ hours—or—Tour of Hotel Kitchen and Bakery

THURSDAY, JANUARY 20, 11:00 A.M.

Sunbathing—Salt Water Baths

THURSDAY, JANUARY 20, 1:00 P.M.

Ladies Luncheon—Carolina Room—Fashion Show given by Moore Institute of Art, Philadelphia, Pennsylvania; 15 models

FRIDAY, JANUARY 21, 9:00 A.M.

Coffee Get-Together—Registration Room-Stair Hall—Lounge Floor

FRIDAY, JANUARY 21, 9:30 A.M.

Tour of Lenox China Factory, Pomona, New Jersey; via Chartered Bus; 1½ hours—or—Tour of Hotel Kitchen and Bakery

FRIDAY, JANUARY 21, 2:00 P.M.

Afternoon Tea—Music Room—Gertrude Neidlinger, Concert Comedienne—"Program of Musical Mishaps"

SESSION A—Continued

THURSDAY AFTERNOON

Vacuum Forming—Bowman Stratton; Auto-Vac Company

Modern Applications For Modified Styrene Sheet—Robert Hrudka; Chicago Molded Products Co., Campco Div.

Recent Advances With Isocyanates Base Resins—Irving Katz; N. American Aviation Co.

Applications For Epoxy Resins—Jerome Formo, and L. Bolstad; Minneapolis-Honeywell Co.

SESSION B—Continued

Mold Parts of Hard Electro-Formed Nickel—W. J. B. Stokes, II; Stokes-Trenton, Inc.

TOOL STEEL PANEL

Selection of Materials in Mold Construction—G. E. Brumbach, Carp Steel Co.; Jack Morrison, Detroit Mold Eng. Co.; H. C. Becker, Crucible Steel Co.; S. G. Fletcher, Latrobe Steel Co.

6:00 P.M. President's Reception—Cocktail Party in the Chalfonte Lounge.

7:00 P.M. BANQUET—Address by General C. J. Bondley—Entertainment—Drawing for Door Prizes.

FRIDAY, JANUARY 21, 8:45 A.M.

Invocation by the Very Rev. John T. Sheehan, St. Nicolas R. C. Church

REINFORCED PLASTICS PANEL

Moderator—J. M. Scott, Winner Mfg. Co.

Design Considerations in the Use of Reinforced Plastics—H. L. Darby; Winner Manufacturing Co.

Properties & Uses of Reinforced Plastics & Other Related Materials—Edward Colwick; Winner Manufacturing Co.

Sandwich Panels—Arthur Douglas; Winner Manufacturing Co.

Reinforced Plastics & Other Related Materials—Thomas Scheirer; Winner Manufacturing Co.

Factors Affecting Production Tooling for Reinforced Plastic Components—S. Fingerhut, with P. Levy, J. Marzicola, O. Silverwood, and G. Stamos; Zenith Plastics Co.

Development of Test Requirements for Container Grade Reinforced Plastics—J. W. Case; Navy Bureau of Ordnance

INJECTION MOLDING PANEL

Moderator—E. W. Cronin, Hercules Powder Co.

Runnerless Molding—Ernest Moslo; Moslo Machinery Co.

Stock Thermocouples, Pressure Gauges, and Rupture Discs for Use on Plastic Extruders—E. C. Bernhardt; E. I. DuPont Co.

Temperature & Pressure Measurement in Heating Cylinder, Injection Machine—C. E. Beyer; Dow Chemical Co.

Temperature Variations in Heating Cylinder—R. B. Dahl; Dow Chemical Co.

Design of Injection Mold Machine Heating Cylinder—R. B. McKee; Dow Chemical Co.

12:30 P.M. Formal Luncheon — Address by Mr. John LaCerda, President of the Poor Richard Club, in the Carolina Room.

FRIDAY, JANUARY 21, 1:30 P.M.

POLYETHYLENE PANEL

Moderator—W. F. Oelman, Standard Molding Corp.

Will the Polyethylene Gamble Pay Off?—Ed Childs; Monsanto Chemical Co.

Molding For Quality—R. E. Dunham; Owens-Illinois Glass Co.

Progress in Polyethylene—J. E. Brister; Bakelite Corp.

What Makes the Sale?—Charles Harper; Sears, Roebuck & Co.

RESEARCH PANEL

Moderator—Bryce Maxwell, Princeton University.

Pressure Inside Mold During Phenolic Molding—J. M. Rausch; Bell Telephone Co.

Calculation of Rolls Separating Force In Calendering and Milling—F. D. Dexter, and D. I. Marshall; Bakelite Corp.

Solids Conveying In Extruders—U. H. Darnell, and E. A. J. Moe; E. I. DuPont Co.

Corona Properties of Insulating Materials—W. T. Starr; General Electric Co.

SESSION C—Continued

A New Method of Studying the Outdoor Exposure Resistance of Plastics—W. F. Bartoe; Rohm & Haas Co.

18 Successful Years of High Pressure Hot Water Process Heating in Plastics Plant—E. G. Hansen; J. O. Ross Engineering Co.

FRIDAY, JANUARY 21, 9:00 A.M.

Moderator—Frank W. Reinhart, National Bureau of Standards.

Coefficient of Friction of Teflon Against Steel—J. B. Thompson, with O. C. Turrell, and B. W. Sandt; E. I. DuPont Co.

Bonding of Teflon—P. J. Wayne, and W. M. Bruner; E. I. DuPont Co.

Welding and Flame Spraying of Plastics—Dr. J. A. Neumann; American Agile Co.

Engineering of Silicone Rubber Parts—S. K. Moxness; Moxness Tool Co.

Importance of Market Development in Promotion of Product Application and Sales—R. E. Brannan; Bakelite Co.

SERVING THE CUSTOMERS OF NEWARK DIE

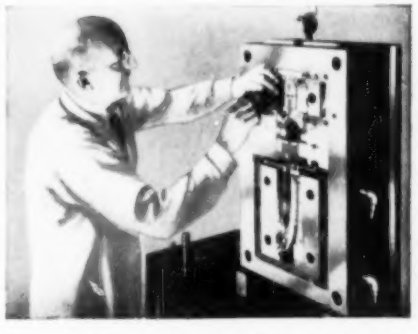
all combine to turn out molds

that meet the most exacting requirements of the molders and users of plastic parts

SPECIALISTS IN MOLD ENGINEERING

THE HANDS OF SKILLED CRAFTSMEN

THE MOST MODERN EQUIPMENT



AND RIGID INSPECTION

At every stage from the study of the blueprints or models for the plastic part to the completion of the finished mold, Newark Die brings to its customers the skill and experience resulting from more than 30 years of precision moldmaking.

Old skills—new machines—turn out the molds that have kept the same molders coming back to Newark Die, year after year. The type of mold, too, that keeps molders' *customers* coming back to *them* year after year.

Write for free booklet "SOLVING BIG MOLD PROBLEMS"

NEWARK DIE COMPANY

22 SCOTT STREET, NEWARK 2, N. J.

Phone: MArket 2-3305

NDCO TRADE MARK

Figure 4. Charging the furnace with cullet.

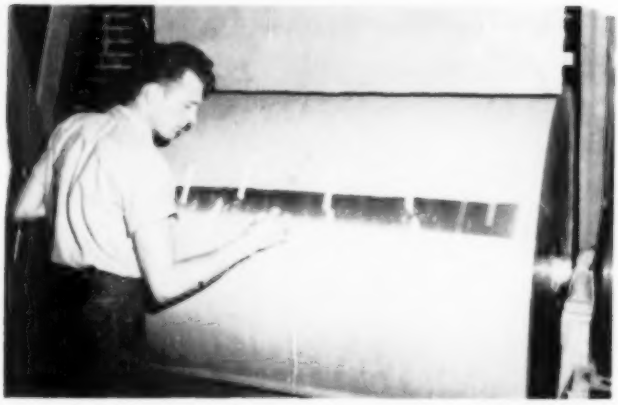


Figure 5. Prior to run, the collecting drum is surfaced with kraft paper which serves as temporary backing for the glass fiber mat.

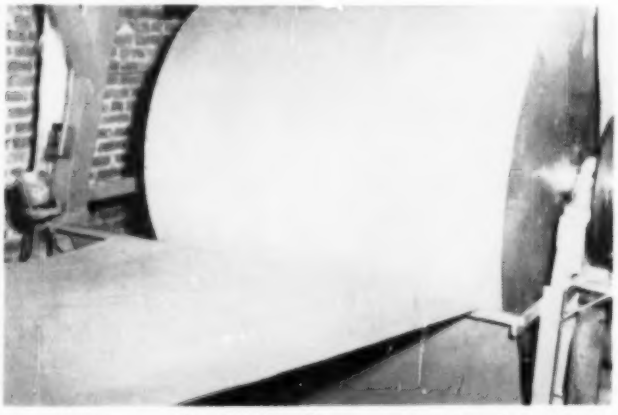


Figure 6. Run completed. Glass fiber mat is cut lengthwise of drum and then withdrawn as a rectangular sheet.

Figure 7. Parallel glass fiber mat completed ready for laminating.

cates perfect elasticity from zero load to rupture, thereby agreeing with Andregg (4). Since this test was made with specially designed equipment having high accuracy and sensitivity, this characteristic of glass fiber is considered to be established.

Now with such an ideal reinforcing fiber at hand, the important question remains, "To what extent can the fine characteristics of glass fiber be built into reinforced plastics?" This question and the ultimate answer to it were incentives for the establishment of a project under the sponsorship of the Navy Bureau of Ordnance (7) (8) early in 1953 to investigate carefully some of the important phases of the problem.

PROJECT SPONSORED BY THE BUREAU OF ORDNANCE

This project was set up to actually produce the desired type of glass fiber and develop the necessary bonding system for use in lamination. Taking a lesson from the ancient bow makers, the concept of equalized loading on glass fibers in a parallel pattern was of first importance. Equipment for collecting glass fibers in a non-woven form had been in use for a number of years (9). However the glass product had not been adopted generally to the reinforcement of plastics due to the lack of proper fiber finishes, binders, and so on, as well as the difficulties of handling and fabrication. It was thought, however, that a great reward awaited the successful development of such a non-woven reinforcement, and therefore this type of fiber collecting equipment was the central unit of the laboratory which was set up in the early part of 1953 for the investigation. The highlights of this project can now be reported.

GLASS FIBER SPINNING EQUIPMENT

This equipment and the general steps followed for the production of pilot quantities of parallel glass fiber mat for experimental purposes are illustrated in Figures 2 to 7 inclusive. The production of a satisfactory glass fiber depends a great deal upon the glass furnace and bushing plate, Figure 2. The furnace body was lined with refractory and served as a pot for melting the glass to a liquid state and holding it at an even temperature, which in this case was in the neighborhood of 2400°F. The bushing plate was made of an alloy steel to withstand the temperature. One hundred holes in this bushing plate permitted the liquid glass to collect in the form of drops by gravity, at their outlets. The glass fibers were taken from these points by first drawing off rather coarse fibers which were caught on the spinning drum. This gave the fibers a linear speed of about 3000 ft/min., thereby attenuating the large glass drops at the bushing plate into fine fibers about .0005" diameter.

While this operation was going on, chemical sizes were reacted with the hot fibers in the "magic box." During another part of the project, resin binder systems were applied to the fibers near the collecting drum, Figure 3. One hour of steady operation usually produced a "four pound Mat" (Mat 6 ft. x 12 ft. weighing 4 lbs.), Figures 6 and 7. The convenience of this setup in this investigation will be quite apparent. For instance: freedom from end uses other than as a direct plastics reinforcement permitted complete disregard of any necessity of weaving the fiber into fabric together with elimination of conventional fiber lubricants; glass could be collected, laminated with plastics and tested all in the same day and the equipment had capacity for production of fiber for prototype use, if desired.

GLASS

While the glass fiber collecting equipment chosen was adapted to the production of fiber from commercial

glass cullet (soda-lime-silica glass), a heretofore unaccepted material for plastics, it was reasoned that: (a) The convenience and availability of the equipment precluded the choice of other glasses; (b) Problems such as fiber finishes, binders, handling, fabrication, etc. could be worked out on this glass and the results translated to other glasses; and (c) Other glasses could be drawn and collected on the same equipment with modifications at a later date if necessary. Therefore, soda-lime-silica glass fiber was used in the entire investigation. At the beginning and for most of the project, this was made from commercial cullet. Toward the end, however, the supply of cullet ran low and was supplemented by broken window glass from a local glazier.

GLASS FIBER SIZE AND BINDER SYSTEM

It had been postulated during the project planning that an improved bond between fiber and plastic resin would show up as improved strength in the laminate. A bond or "binder system" was also quite apparently necessary, for the parallel type fibers were otherwise difficult to handle and fabricate. Since the project was set up to draw and collect virgin fibers, which were not intended to be woven into fabric form, or abraded in other mechanical processing equipment, there was considerable freedom in developing a system to suit the virgin fiber surface.

The first phase, called the "size" or "chemical treatment" was investigated by reacting various chemicals as vapors or in solvent solutions on the virgin fibers in the hot zone adjacent to the furnace bushing in an enclosure called the "magic box." After determining that this phase should be kept separate from the binder system investigation described below, the fiber product was produced in a truly parallel pattern and made into 0.3" diameter rods with polyester resin. Lacking an absolute test for adhesion, flexure tests on these rods were then made to determine the merit of the hot zone size. While no size was shown to be outstanding above the others, measured flexural strengths of 120,000 psi were obtained from the soda-lime-silica fiber rods. This was on par with rods made of commercial "fishing rod" roving (114 finish) by the same technique. This work is being continued to evaluate many other chemical sizes and develop a better method for determining the degree of adhesion at the glass fiber interface.

The second phase of the glass-resin bond investigation, called the "binder" somewhat overlapped the work on the hot zone size and refers particularly to compounds which were applied to the glass fibers by an accurately metered spray gun near their point of tangency with the collecting drum. In this manner, thorough coating of all the fibers with the binder system was assured. The completed glass fiber product was in the form of a mat, 12 ft. by 6 ft. and about .015 in. thick (See Figure 7). The binder developed consisted of a blend of epoxy resins in a solvent solution. As removed from the collecting drum, the uncured binder held the mat in a quite firm condition ready for handling and fabrication. Figure 8 illustrates the success of this development in preventing the "washing" of the parallel type fibers in the laminating press.

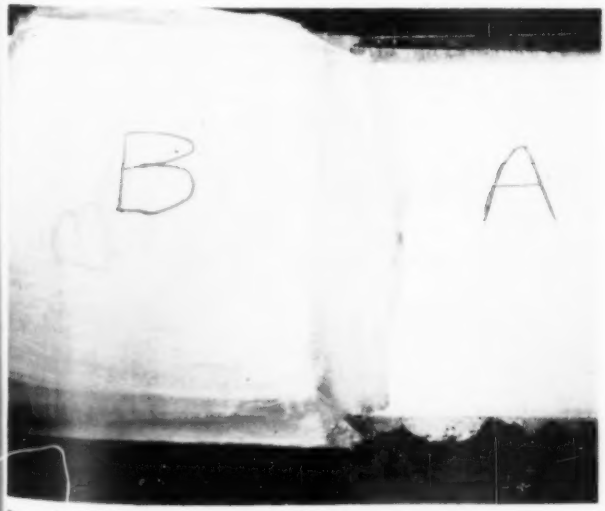


Figure 8. Binder system prevents 'washing' or transverse movement of fibers during lamination. (B) No binder used, serious washing. (A) Binder used, no washing.

The parallel glass mat so produced was cut into 12 in. x 12 in. sheets and then cured in an oven. Following this, the sheets were made into seven ply laminates for flexural tests, thereby providing a direct means of evaluating the glass resin bond which was contributed by the binder system.

RESINS

Since, as already stated, the purpose of the project was to investigate parallel glass fibers and glass-resin bonds, it was desired to keep the other variables to a minimum, and therefore, only one laminating resin was used throughout the project. This was a good grade commercial polyester.

THE IDEAL LAMINATE

The parallel* type glass fiber mat which was produced by the method described provided a very convenient basic reinforcement for the maximum utilization of glass fiber strength in a laminate.

While the product could be made into cross-plied laminates with 90°, 45° or 30° between the fibers of alternate plies (thereby obtaining a near-isotropic structure), there was need for a set of physical data on the simplest structure that could be produced rapidly with available laboratory facilities. Therefore, a simple seven ply laminate was chosen. For this, seven plies of the four pound mat were laminated with the fibers of adjacent plies at 90 degrees to each other and the fibers of the outer plies running in the same direction. The laminate so made was adopted as a standard from which to cut samples for ASTM tests.

Aside from the planned tests to be made, the laminate exhibited quite visible qualities of high strength and unique appearance: When struck with a hammer, a clear note was given out; It was quite stiff and unyielding to bending with the hands; When flexed by main force to near the rupture point and released, no permanent set from a flat plane was visible; The near-parallel pattern of the fibers produced a distinctive and quite ornamental grain at the surface. These and other very interesting observations on the new laminate promised the satisfaction that had been anticipated in a product which accomplishes an efficient use of glass fiber reinforcement.

FINAL TEST RESULTS FROM FLAT, PARALLEL FIBER LAMINATES

As has been stated, the flexure test (L-P-406b Method No. 1031) had been chosen as a means of determining the relative improvement of the binder systems to the glass-resin bond. While the test result, or ultimate strength is based upon a formula that has been agreed upon and used through the years, there was considerable justification in

* *Actually, the fibers were parallel only in each alternate fiber layer of the mat. Due to the furnace traverse, there was a small angle between the fibers of adjacent layers.*

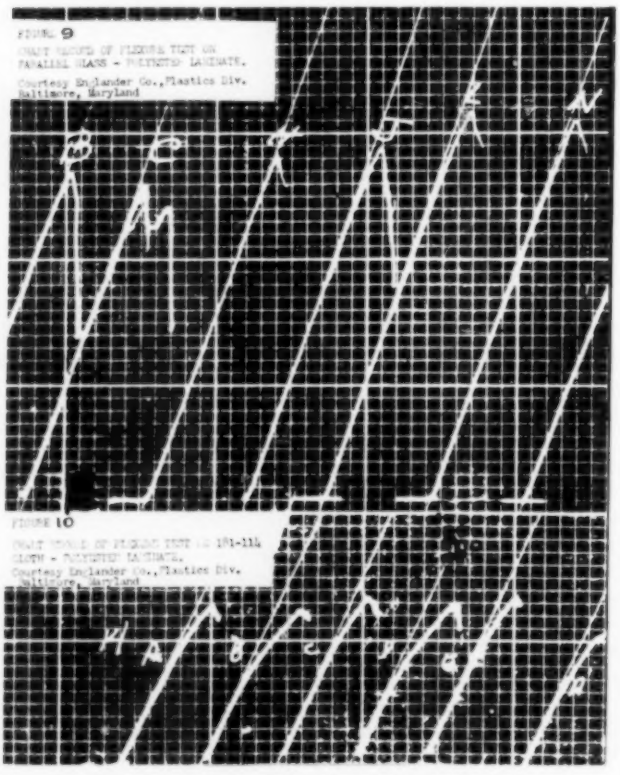
settling on this test method for the parallel laminates, because results by this method are quite widely quoted in the literature. In any event, the test results on the parallel laminates should be compared with those of conventional laminates, such as glass cloth, and therefore, numerous samples on the latter variety were first made to "zero in" the investigation.

Considerable further exploratory test work became necessary to establish procedure on the parallel glass laminates, for it was at once quite evident that the standard flexure test did not bring out the full strength values contributed by the parallel fibers. A span-depth ratio of 24 to 1 was finally adopted for this test, thereby permitting the parallel fibers to be stressed to their rupture point without shear failure within the specimen, as had been experienced when tested at the standard ASTM span-depth ratio of 16 to 1.

As soon as these preliminary test problems were worked out and the testing of samples made more or less routine, the load-deflection curves of the parallel glass laminates began to appear fairly consistently on the recorder chart of the flexure test machine as long straight lines with a sharp peak at the rupture point, which was usually also marked by a sharp report, indicating that the glass fibers were holding on to the last and finally all letting go together.

Here was reward for several months of effort to translate the strength qualities of glass into a laminate! A fair sample of these curves is shown in Figure 9, which is an actual chart reproduction of L D curves of parallel glass laminates in flexure, enlarged about two to one. Likewise, Figure 10 is a chart reproduction of flexure tests on glass cloth laminates to the same scale. The accompanying tabulation in Table I gives actual test values from these curves.

Now, let us see what Figures 9 and 10 tell us, for this is the target that got its inspiration from the "lost art" of the Egyptians and the Turks. It is at once seen that the



Figures 9 and 10. Results of flex tests of glass laminates.

L D curves of the parallel laminates are long straight lines with their points of departure (elastic limit) very near the rupture points. Quite obviously, this characteristic is a true reflection of the performance of glass fibers, working together. A question might be raised, that if glass has no apparent yield point or elastic limit below the ultimate, why are these curves not straight all the way? This could be attributed to the possibility that a small proportion of the fibers were not properly aligned to take their share of the load, or that the glass-resin bond system was too weak to force parallelism of the fibers to the last instant, or both. This observation has not, as yet, been verified.

In comparison to these curves, those of the glass cloth laminates are short, curved lines with elastic limits not only much lower numerically, but much lower in proportion to the ultimate strengths. A comparison of the average elastic limits for each set of curves in Figures 9 and 10 brings out the striking fact that the useful strength of the parallel glass laminate is over three times that of the cloth laminate. And it must be remembered that this improvement in the strength of reinforced plastics has been accomplished by means of glass fibers which were made from common soda-lime-silica glass.

CONCLUSIONS

While many other conclusions may, and probably will be drawn from this report on the development of parallel glass fiber, the following are considered important:

1. The ancient principle of parallel fiber reinforcement, when applied to reinforced plastics, contributes greatly to useful strength.
2. The adhesion between glass fiber and plastics may be improved by finishes which are applied to the virgin fibers as they are drawn and collected.
3. Parallel (non-woven type) glass fiber reinforcement, ready for immediate lamination with plastics, may be

(Please turn to page 54)

TABLE I

Comparison of Flexural Strength of 181-114 Glass Cloth and Parallel Glass Laminates. (Polyester Resin)

SAMPLE	ULTIMATE STR. PSI.	ELASTIC LIMIT PSI.	MOD. OF ELAS. X 10^6	
	181-114 GLASS CLOTH			
A	47,700	26400	2.39	(1)
B	46,200	24100	2.40	(1)
C	49,300	30500	2.66	(1)
D	49,200	22900	2.63	(1)
E	50,900	30400	2.57	(1)
	54,400	34200	2.8	(2)
	PARALLEL GLASS (7 PLY AT 90°)			
B	101,800	97000	—	(1)
C	97,600	89000	—	(1)
H	105,500	101000	3.36	(1)
J	107,300	85000	3.47	(1)
L	119,000	94000	3.59	(1)
N	115,500	99000	3.36	(1)

(1) FROM ENGLANDER CO., PLASTICS DIV., BALTIMORE, MD., CONTRACT NORD—13462.

(2) FROM DATA BY FOREST PRODUCTS LABORATORY, MADISON, WIS.

THE *Injection* MOLDERSCOPE

By A. R. Morse

President, Injection Molder's Supply Co.

"It is the freedom to disagree, to quarrel with authority, in intellectual matters to think otherwise, that has made this nation what it is today." Dr. James B. Conant

Rating of Injection Machines

One of our trade's regrettable tendencies has been to regard an injection machine as something that can be set up by itself in a garage where it will coin money all by itself. That day is fast drawing to a close. Some engineering is becoming necessary too. A knowledge of mold design (and redesign) is daily becoming more important as concerns with improved molds prove as they forge ahead. Greater familiarity with more types of materials including the new copolymers—is a necessity. But paramount in my opinion today is the need for understanding how to rate a press correctly. This is something on which only the bare minimum of work—hardly a start—has been done.

This matter of rating injection machines can offer a real challenge to SPE, as no other way can the average molder have a real standard of reference. It is encouraging to note that a few progressive injection molders already understand many of the problems posed by rating. On their own initiative a few concerns have already gone far to doing something concrete about rating their machines realistically, but the problem is still an industry-wide one.

The amazing variety of heating cylinders being used on one size of press alone today will indicate the scope of the problem. One make of 16 oz machine has wattages that range from a low of 10,000 to as much as 28,000. On another make of 8 oz press, wattages used range from 7500 to over 22,000—yet each molder who owns these presses honestly believes his is the "standard"; and the 7500 watt machine is expected to perform like the 22,000 watt because both were of the "8 ounce" classification.

While the publication of more details of press specifications will help, still the SPE should consider setting up a central committee to analyze these specifications against a common frame of reference so that more effective press comparisons of press performance can be made prior to purchase. This need for a constructive program of rating injection machine capacity to accord with actual press performance on present day molding powders is something proven every working day in our own independent studies of all the various machines to which we are fitting uniform design heating cylinders.

Presses must not only be rated in one grade of styrene, but in polyethylene, vinyl, acrylic, and butyrate as well. Today it is almost impossible to translate a given rating either in ounces or in pounds per hour from one family of molding materials to another and not get into molding trouble of some kind or other. A committee of molders could readily work out the details of this vitally needed cross-referencing and accomplish much in the way of immediate benefits—lower maintenance costs and better parts. The bulk of this information must come from a pooling of molders' experience with the various machines and materials, and that is why I propose it be undertaken by a committee of injection molders, and not by the machinery or material people. The actual ratings could then be charted and submitted to sub-committees from the machinery and material groups. Standard press comparison sheets could easily be prepared and circulated among molders. Most interesting section meetings could be scheduled in the form of open hearings of the local committee whose chairmen could be appointed by the national committee, and this would give everyone with an idea on the subject a chance to be heard and to openly express an opinion.

Yes, a program of classification of press capacities could be one of the greatest contributions the SPE could make. The initiative however, should come from the molder to be effective because no more serious problem faces him today than knowing how to relate press specifications to a given set of molding conditions. Such a program as I propose will require real courage to see it through because it will disclose that a staggering obsolescence factor faces the modern injection molder. The competition from low pressure molding and vacuum forming is as nothing compared to the forthcoming internal competition from new 1955 presses with revised ratings. Correct press rating is our industry's most serious problem, not only of new machines, but of the vast number of older machines, because you can't put a model T on the same race track with a Cadillac and come out ahead by putting up even money on the race. Rating presents a wonderful challenge to SPE's injection molder members. Will they do something about it?

Newark

Bonanno Honored

D. J. Mullins

Approximately 200 members, guests and their ladies attended the annual Christmas dinner and dance of the Newark section S.P.E. which was held in the main ballroom of the Military Park Hotel on December 8th. Professional entertainment, a multitude of gifts and a special dinner menu selected for the occasion resulted in a merry and enjoyable evening.

Incumbent President Joseph Bonanno announced that the officers for the Newark Section for 1955 will be the following:

President — William Willert; Vice-President — Don Biklen; Secretary-Treasurer — Robert Hoehn; Director — John Lombardi; Director — Ed. Soules; Director — Robert Bartlett. Peter W. Simmons was elected a National Director.

After incumbent President Bonanno had thanked the officers, directors and committeemen who had served with him during his term, President-elect Willert presented Bonanno with a plaque on behalf of all the Newark Section members which lauded Bonanna for his unselfish devotion of time and effort to the Society.

Willert then reviewed Bonanno's outstanding presidential term which saw an increase in Newark Section membership, which now numbers over 400 members, and the establishment of a course in plastics technology which will be instituted by the Newark College of Engineering in January 1955 in cooperation with the Newark Section, S.P.E.

Chicago

Officers Elected

R. D. Hanna

At the December 20 meeting of the Board of Directors, Chicago Section, Society of Plastics Engineers, new officers were elected to serve for the year 1955.

The new officers are as follows:

President — R. K. Gossett, Gossett and Hill Co.; **Vice-President**—Franklin L. Fine, Rohm & Haas Co.; **Secy-Treas.** — Kenneth A. Rouzer, General American Transportation Corp.

cellular polyethylene

W. T. Higgins
Bakelite Co., Division of Union Carbide and Carbon Corp.

An intensive product development program on the part of plastic suppliers and fabricators has resulted in wide fields of application for polyethylene. The good abrasion resistance, chemical resistance, flexibility, toughness, light weight, low moisture absorption, high resistivity, low electrical loss characteristics, and ease of processing make polyethylene well-suited to a large variety of end uses. Certain applications, however, require properties not obtainable from the solid material, and for this reason a cellular polyethylene has been developed. By combining polyethylene properly with an inert gas, a cellular structure consisting of discrete cells of gas in the polyethylene resin is obtained. The properties of the base resin are thus changed to achieve lighter weight, lower dielectric constant, lower thermal conductivity, and greater bouyancy with little or no sacrifice in chemical inertness, moisture resistance, low temperature behavior or power factor.

The commercial applications, mostly electrical, in which this material has been used have been satisfactory. Normal extrusion equipment has done an excellent job and only a few changes in technique are necessary to produce a good product.

DISCUSSION

Cellular polyethylene is made with techniques which produce an intimate dispersion of a chemical blowing agent in polyethylene resin. The blowing agent is a thermally sensitive chemical which liberates gas at a specific temperature. The correct choice of the blowing agent is a critical one for it must meet several unusual requirements. For example, the blowing agent itself, the gas it liberates, and the residue product must not absorb moisture since water is obviously detrimental to the good properties of polyethylene. It should be odorless, nondiscoloring, nonblooming, and nontoxic. It is also desirable that the blowing agent liberate large volumes of gas and leave as little residue as possible.

EXTRUSION

The blowing agent must be made to liberate its gas under controlled conditions. Thus far, cellular polyethylene has been handled most satisfactorily in an extruder. Other methods of forming the material are under investigation, but because the extruder maintains pressure constantly on the product, it is most readily adaptable to providing the controlled conditions required during the liberation of the gas.

Aside from its normal operation, the extruder in this case must perform two additional functions. The first is to cause the blowing agent, by application of heat, to liberate the gas. The second is to maintain sufficient pressure in the barrel, head, and die to prevent expansion of the liberated gas before it emerges from the die. When the machine is doing these functions properly, the product has a smooth surface, a uniform bubble size, and a uniform cellular structure. Machines having a screw length to diameter ratio of 12 to 1 or better have been found more effective than extruders having lower ratios. The best machine conditions are those which give the lowest density at the lowest compound temperature. To determine the optimum conditions for a particular extruder, it is recommended that the barrel and head temperatures be set at 300 deg. F. and 250 deg. F., respectively, and the density of the product measured. The barrel and head temperatures should then be raised to 25 deg. F. increments until a density of .47 is achieved. Operating temperatures higher than necessary give less uniform bubble size, a rougher surface and increase the cooling difficulties.

Several other factors, which are not normally encountered, must be considered in the extrusion of cellular polyethylene. A dense screen pack is needed to ensure pressures in the barrel sufficiently high to prevent premature expansion of the gas. Screen packs of 20/60/100-100 mesh screens have been effective. Head and die pressures are kept high by using a low head temperature and a die designed to restrict the flow of the material; that is, as the die opening increases, it is necessary to increase the die land length to prevent expansion. The exact length will vary with the machine and the optimum operating conditions. Premature expansion makes itself apparent by die plating or curling of the compound at the face of the die. This is accompanied by a rough surface. When properly extruded, the cellular polyethylene will expand 100 per cent, doubling in volume. The area of the die opening should be 50 per cent of the area of the finished extruded products. For complex shapes the trial and error approach is the only known method of die design.

The screw temperature should be maintained between 75 deg. C. and 100 deg. C. Low temperatures result in uneven heating while higher temperatures causes the com-

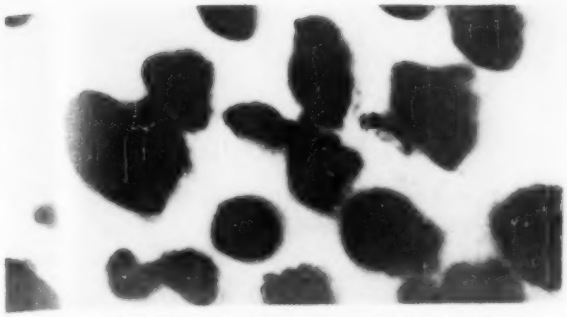


Figure 1. Cellular polyethylene magnified 450 times.

pound to stick to the screw and reduce output. High compression ratio screws have been slightly more effective than those having a low compression ratio.

In the case of wire coating, the wire should be preheated to 100 to 125 deg. C. to ensure a smooth regular surface. Lower temperatures give a lumpy product while higher temperatures result in erratic cooling and flattening of the insulation.

The cooling of the finished product is often difficult. For thin sections direct water cooling is possible. Where heavy sections are involved, a long stretch of air cooling is desirable. If the product is water-quenched too rapidly, it will flatten due to the weakness of the extruded coating at the extrusion temperature. Rapid contraction of the occluded gases before the polyethylene has developed any strength contributes to this deformation. Both these tendencies are minimized by using the lowest possible compound temperature.

GENERAL PROPERTIES

Because cellular polyethylene is 50 per cent gas, it can easily be predicted that certain properties of the polyethylene will be degraded while others will be improved. Table I illustrates the effect of the gas on some of the common properties of polyethylene.

It should be noted from the table that the tensile strength, elongation and dielectric strength of the cellular compositions are degraded when compared with solid polyethylene but are still in a range which permits the use of this compound in many applications. The power factor values are essentially the same. The dielectric constant is very much lower, and hence the cellular material exhibits lower dielectric losses than the solid polyethylene. The very low density is desirable where reduced cost and weight, decreased thermal conductivity, and increased buoyancy are important.

MOISTURE ABSORPTION

Cellular polyethylene has a unicellular structure; that is, each bubble or cell is completely enclosed in a shell of polyethylene. The enlarged photograph in Figure 1 shows a picture of the actual structure of the expanded material. The dark areas shown are the cells. Because each gas cell is completely closed, the moisture permeability of this composition approaches that of solid polyethylene. Figure 2 shows the percentage of moisture absorbed by solid and cellular polyethylene samples during immersion for 100 days in tap water at 23 deg. C. Although the cellular material picks up water rapidly at first, once the relatively few open surface cells are filled, no further increase in absorption is observed. Figures 3 and 4 show the effect of this exposure on the power factor and dielectric constant of both materials, respectively.

(Please turn to page 52)

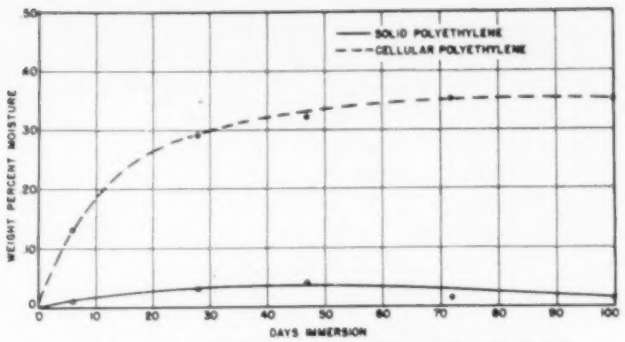


FIG. 2 WEIGHT PERCENT MOISTURE ABSORBED vs DAYS IMMERSION TAP WATER - 23 DEG. C.

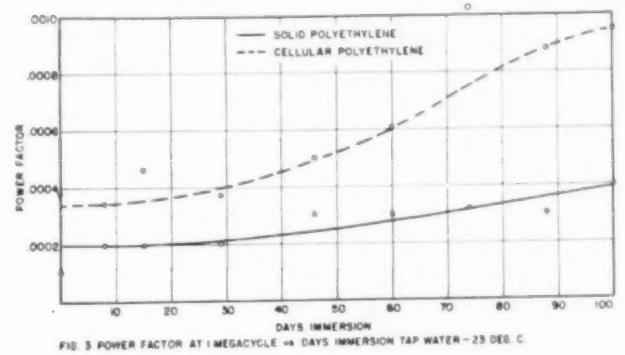


FIG. 3 POWER FACTOR AT 1 MEGACYCLE vs DAYS IMMERSION TAP WATER - 23 DEG. C.

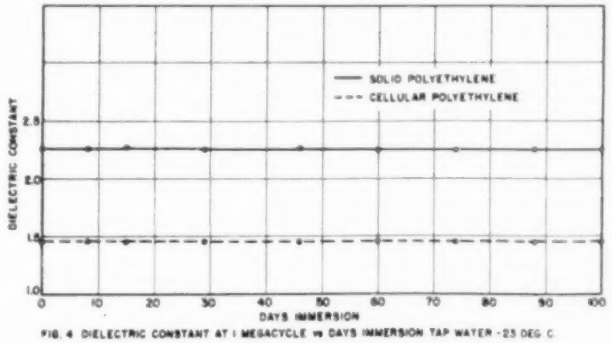


FIG. 4 DIELECTRIC CONSTANT AT 1 MEGACYCLE vs DAYS IMMERSION TAP WATER - 23 DEG. C.

Table I
GENERAL PROPERTIES

	Solid Polyethylene	Cellular Polyethylene
Specific Gravity	.92	.47
Tensile Strength, psi @ 23°C	2180	670
Elongation, per cent @ 23°C.	580	310
Dielectric Strength, ASTM D149-44		
Short Time @ .125"	630 v./mil	220 v./mil
Step by Step @ .125"	590 v./mil	190 v./mil
-55°C. Mandrel Bend, 2X	OK	OK
Power Factor @ 1,000 cycles	.00028	.00033
10,000 cycles	.00030	.00038
Dielectric Constant @ 1,000 cycles	2.3	1.48
Dielectric Constant @ 10,000 cycles	2.3	1.49
Thermal Conductivity Cal./cm²/sec/°C/CM	8.0 x 10^{-4}	2.8 x 10^{-4}

AROUND THE WORLD

★

AUSTRALIA

PLASTICS NEWSLETTER

Vol. 4, No. 5, September, 1954

Abstracter: Albert Lightbody

PIA SUBCOMMITTEE REPORT ON EDUCATION, p. 3

The Plastics Institute of Australia Subcommittee on Education reports progress in many educational institutions. The University of Kensington New South Wales, has installed compression, injection and extrusion equipment, primarily for studies by post-graduate students. The Melbourne Technical College has commenced a five year course in plastics technology. The South Australian School of Mines has expanded its diploma course in industrial chemistry to embrace special study in plastics technology.

PIA STATEMENT OF PRINCIPLES, p. 1

The PIA has adopted a Code of Honor very similar to that recently adopted by the SPE and SPI of the U. S. with respect to the understanding, use, selection and selling of plastics materials and articles.

★

FRANCE

INDUSTRIE DES PLASTIQUES MODERNES

Vol. 6 No. 8, Sept.-Oct., 1954

Abstracter: Hans Mayer

ELECTRONICS AND PRINTED CIRCUITS.

The future development of manufacturing methods in the production of electronic and electric devices depends to a large degree on the progress in the use of printed circuits and this in turn will depend on the nature and qualities of the material which carries the circuits and provides the insulation. The five methods used in the manufacture of printed circuits are described:

(1) transfer of the metal by mask spraying.

(2) transfer by means of plating on conductive type ink.

(3) embedment of the complete circuit, separately prepared, in one piece into the insulating material.

(4) impression of silver by means of a heated stamping die.

(5) covering the surface of the insulating material with metal and removing the undesired portion by etching.

THE QUESTION OF POLYETHYLENE IN PACKAGING.

All packaging materials like paper, metal foils, plastic films, etc. have their advantages and disadvantages. None of them, by itself, will fill all the demands for a universally useful material. Tests have been made to combine polyvinyl and polyethylene films or aluminum foil and polyethylene for particular demands on packaging. Of a more general approach the combinations of paper with polyethylene seem to be most promising. The types of paper use, the methods of application of the polyethylene deposit, the possible decorative and transparent effects as well as the physical properties of the resulting product are described.

PLEXIGLASS IN THE LIGHTING FIELD—G. Compagnon.

The high light transmission, the light weight, excellent aging qualities, the colorfastness and the ease of application make acrylic parts desirable for use in lighting applications where they are not subjected to extreme temperatures or certain gases.

LARGE INJECTION MOLDINGS AND INJECTION SPEED — P. E. Schmidt.

The need for short injection cycles for the purpose of eliminating stresses and sinking in of the surface of the moldings is demonstrated by a number of examples.

11th Annual
SPE CONFERENCE
Atlantic City—Jan. 19-21
"Growth Through Engineering"

★

GERMANY

PLASTE UND KAUTSCHUCK

June ,1954

Abstracter: Walter Brenner

NOTES ON THE AIMS OF MACHINE DESIGN IN THE DEVELOPMENT OF THE RUBBER INDUSTRY, by H. Eichstadt

The primary task of reconstruction of the German rubber industry following World War II was getting factories back in production. In order to achieve this goal, it was essential to both rebuild damaged machinery and to construct new machines reflecting in design the latest developments in the rubber technology. The paper discusses various types of rubber mixers, presses, and instrumentation for the same in some detail. Considerable emphasis is placed on the use of electric power for the operation of mixers, dryers, etc. The technical outlook of the rubber industry is held to be less progressive than that of the plastic groups, especially as regards equipment design.

THE SEMI-AUTOMATIC PRESS KUPYH 100, by G. Lottmann, R. Brauer, and G. Ott

One of the most desirable properties of plastic press equipment is versatility. The Semi-Automatic Press Kupyh 400 has a degree of versatility unmatched by most other presses in this field. This machine is actuated electro-hydraulically. A high pressure pump with a maximum pressure of 250 Kg/cm² and a low pressure pump with a maximum pressure of 40 Kg/cm² (positioned on the right side of the press) are essential components. The press is constructed in such a manner as to permit easy approach in all directions. Full automatization can be effected if desired. Sketches illustrate construction, rams, platens, instrumentation, etc.

MOLDINGS FOR THERMO PLASTICS, by W. Rubisch

Consideration is given to materials for the construction of molds to be used for thermo-plastics. Chrome nickel steels are recommended for injection molding large production runs.

The technology of mold production is discussed with special emphasis on hobbing methods. A scheme for steam heating for both molds and platens is presented. Design details for proper mold construction are illustrated. The subject of ejector pins in injection molding is also discussed.

★

KUNSTSTOFFE

Vol. 44, No. 10, October, 1954

Abstracter: Anne Schwend

This edition which deals primarily with the utilization and processing of unsaturated polyester resins and their reinforcement, is dedicated to the convention of the German Plastics Industry held in Stuttgart in October, 1954. A number of papers presented on this occasion which shall be published in this magazine later, shall round up the picture on glass fibre reinforced plastics.

GLASS FIBRE REINFORCED PLASTICS, by Waldemar Beyer

In order to straighten out misconceptions existing about the possibilities in the application of glass fibre reinforced plastics, this article clearly defines the composition properties of basic materials as well as mechanical, heat, moisture and chemical-resistant properties. The most essential molding techniques—closed molds, elastomeric plungers, pressureless forming and vacuum impregnation the same as the rubber bag and continuous operation methods are characterized. Finally, the author warns against abandonment of conventional production methods and materials unless glass fibre reinforced plastics really constitute a step forward towards better quality and improvement of production techniques.

SPINNABLE GLASS FIBRES—REINFORCEMENT FOR PLASTICS, by Fritz Brockmueller

Spinnable glass fibres are the finest sort of fibres producible having retained most of the physical and chemical properties of raw glass. They are inorganic, non-inflammable, resist corrosion, heat and moisture. They are followed through their various stages of treatment such as primary impregnation with a chemical binder, drawing and blowing of threads, their combination and gathering into rovings, loose chopped strands, mats and staple fibres and their weaving into different kinds of cloth whereby fine yarns yield the best values as regards tensile, flexural and compressive strength but cloth from coarse yarns excels in impact strength. The subject of making glass fibre reinforcements invisible by keeping the light refractive index of glass fibres, impregnating material and resin the same, is briefly touched. High dimensional stability, excellent impact strength and crazing resistance are the remarkable features of compression molded glass fibre filled electrical parts of intricate design. Spun staple yarn is also used as reinforcement for styrol and phenolic granules for processing on conventional machines.

POLYMER PLASTICIZERS, by G. R. Kloos

High molecular polyesters on the basis of saturated bi-functional fatty acids with glycol gain interest as polymer plasticizers for PVC. The results of extraction tests of both saturated polymer ester plasticizers and monomer plasticizers such as DOP, DOS, TCP, etc., prove the superiority of the former. One disadvantage is their higher viscosity for which reason, in practice, one often uses a mixture of polymer and monomer plasticizers.

THE EFFECT OF VARIOUS ADDITIONS ON UNSATURATED POLYESTERS, by B. Berndtsson and L. Turunen

Since the processing of unsaturated polyester resins often requires the user to change the properties slightly in order to reduce the cost or achieve a certain effect, the authors give a report on their investigation with styrol-modified unsaturated polyester resins. Emanating from an explanation of the functions of the two basic components, i.e. unsaturated alkyd and monomer styrol, the influence and task of the catalyzer and accelerator are discussed. Different kinds of peroxides used as catalyzers of high, medium and low temperature in this case, will form free radicals under the influence of heat thus initiating the reactivity of double bonds. Accelerators help the catalyzers in case polymerization is to take place at room temperature only. Chemically, the polymerization process signifies a change in the nature of the bonds which releases energy in the form of heat and thus increases the temperature of the plastics during the curing process. In this connection it is referred to a proposal for standardization of the time-temperature-diagram made by the SPE in 1951 in their proceedings on the Sixth Annual Technical Session.

The effects of styrol additions were investigated in two catalyzer systems, i.e. benzoyl peroxide and dicyclohexyl peroxide which proved that the speed of reaction increased with the increasing styrol addition, thus reducing the gelling time. However, polymerization at room temperature with benzoyl peroxide plus accelerator increased the gelling time at the same ratio as the styrol concentration increased. Although a satisfactory explanation could not be found, it is deduced that free radicals produced on one hand through the influence of heat, on the other hand through chemicals, possess different catalyzing capabilities and therefore react in an entirely different manner during polymerization. Should this be so, it may be rightfully deduced that the chemical structure of plastics produced at room temperature would not be the same as that of those plastics produced at elevated temperatures.

The limit of flexural strength of styrol-modified polyester resins is decreasing with the increasing styrol content, the modulus of elasticity remains constant, so does the resistance against water absorption, the hardness shows almost constancy with a maximum at a ratio of 30:70, while shrinkage increases with the styrol concentration, the same as the second order transition point and the energy released in the form of heat. Addition of fillers, on the other hand, acts as a thinner for the reactive double bonds, causing a prolongation of the gelling time and a lowering of the exothermic peak. The polymerization will be unfavorably influenced if the fillers contain groups of molecules which act as inhibitors or accelerators. A big chart lays down the results of investigations with pigments and colors, particularly under the aspect of influence on the polymerization process.

APPLICATION OF UNSATURATED POLYESTER RESINS WITH PARTICULAR REFERENCE TO PROCESSING IN SINGLE PART MOLDS, by Brian S. Parkyn

Emphasizing first the six main properties of polyester resins:

1. Processing in liquid form which makes it imperative that any trapping of air be avoided;
2. Quick polymerization either under the influence of heat or just by contact with the surrounding temperature mostly under addition of a peroxide catalyzer;
3. Continuation of polymerization long after the resin has become rigid — an important factor upon determination of the physical properties of the cured resin;
4. No gaseous by-products are produced during polymerization;
5. Frequent styrol-modification which makes it imperative to cure at a temperature below the boiling point of styrol;
6. The polymerizing reaction may be postponed or completely impeded by addition of small quantities of moisture, sulphur, coal, metallic oxides or the like,

the author goes into detail on the laminating process of glass fibre reinforced polyester resins. The two basic design groups for continuously working laminating presses—those in which the basic materials are not be-

ing impregnated during the lamination process proper and those where the basic materials are impregnated during the lamination process — and the efforts of the British and U. S. industries to develop such presses are mentioned. All of them, however, to date lack perfection since a lot of material is wasted in case a machine has to be stopped only temporarily.

A discussion of various molding techniques is followed by a description of forming glass fibre reinforced polyester parts of big dimensions, such as boats, on single-part molds. Finally, the economic and price factors are deemed worthy of consideration and discussion.

EXPERIENCES IN THE MOLDING OF POLYESTER RESINS, PARTICULARLY WITH THE PREFORMING METHOD,
by L. Goerden

Since a German company has now introduced on the market a preforming machine—for description see below—it is of great interest to make molders acquainted with experiences gained with the molding technique of glass fibre reinforced polyester resins. By flaking chopped glass fibres on the sieve mold in radial or tangential direction and properly directing the evacuating current of air in the closed apparatus, a very smooth and even surface is obtained. The glass fibre felt on the sieve mold is either dusted with powdery binders and then baked in an oven to melt the resinous particles thus causing a bond between fibres, or liquid binders or binder emulsions are sprayed on the felt. Still smoother surfaces may be had by either flaking another layer of smaller glass fibres on top of the first or by using so-called surface mats, thin fleecelike glass fibre mats which are just put on top of the felt.

While U. S. literature always mentions the low molding pressures of less than 10 kg/cm^2 (142.2330 psi), it has been stated that rejects may be minimized at molding pressures between 10 and 20 kg/cm^2 (142.2330 and 284.4660 psi). It is of great importance that the closing of the molding machine be effected quickly with the exception of the last millimeters which should be closed at the lowest speed possible. For certain parts with high vertical side walls it may be advantageous to even use three different closing speeds for the mold in order to prevent cracking of the preformed part. Cheap molds have not proven acceptable for mass production. The best dies are those with pinching edges since glass fibres may easily be pinched off while it is very hard to shear them off. Although, theoretically, molding temperatures vary between 80 and 140°C., the best temperatures found are between 105 and 115°C. (221 and 239°F.). Exaggerated molding temperatures easily cause the formation of bubbles, while uneven molding temperatures are the cause of stresses in the ready part. The use of fillers will in any case lower the strength of the article, but it may be advisable to add a small percentage of fillers in certain instances where particularly smooth surfaces or great rigidity are required. However, the share of fillers should not exceed 20% of the overall weight. Pigments should only be added in pastry form.

It transpires from the foregoing and is the purpose of this article to demonstrate that for the molding of glass fibre reinforced polyesters methods have been developed which do not only require well designed costly equipment but also skillful molders, but compensate, on the other hand by offering a maze of possibilities.

GLASS FIBRE REINFORCED PLASTICS, by P. R. Masek

Aside from a brief description of commonly used processing and molding techniques for glass fibre reinforced polyester resins, mentioning also the Neoprene dip plunger method, this review deals mainly with the choice and composition of the glass melt, spinning of endless threads, production of staple fibres and fibre mats and their preparation prior to their contact with the resin.

PROCESSING OF UNSATURATED POLYESTER RESINS,
by Hans Weisbart and Edith Behnke

A resume of factors influencing the production of semi-finished and finished plastics based on type of polyester resins and additions used as well as type of reinforcements, fillers and pigments added. This is followed by a brief on processing methods with and without application of heat.

GLASS FIBRE REINFORCED PLASTICS IN THE UNITED STATES

Brief on the 8th Annual Technical and Management Conference, Reinforced Plastics Division of the SPI in Washington, in February 1953.

2ND COLLOQUIUM IN AACHEN ON PLASTICS, by Guenther Rehage

Resume of addresses held on the chemistry and physics of plastics: Prof. Dr. Holzmueller, Prof. Dr. Jenckel and Guenther Rehage reported on various themes of relaxation observations in high polymers; A. Brockhaus and Dr. Sonntag dealt with the decomposition of high polymers, several addresses aired the problem of high molecular substances in solvents, H. V. Lillien's contribution was on the selectivity of ion exchangers, Dr. Schmidt's on polymer 1-Alkoxybutadiene, Prof. Dr. Cruse's on pH-measurements in non-watery solutions, Dr. Haase's on the melt diagram of salt melts.

PREFORM MACHINE FOR GLASS FIBRE FELTS

This machine was developed by Maschinenfabrik Friedrich Büsch, Bad Homburg v.d.hH. It provides a cutter for the strands of fibre glass. The chopped material is sucked into the preform chamber onto the outside of a mold provided with suction holes which is mounted on a turntable. When closing the doors of the preform chamber, the turntable will automatically start rotating in alternating directions, which, in turn, automatically opens the damper to the exhaustor and then sets the cutting device into motion. By setting a time-clock the desired amount of fibre glass may be regulated. Special equipment is designed for incorporating reinforcements, openings and the like.

PRODUCTION OF CHEAP METAL SPRAYED MOLDS FOR LOW PRESSURE MOLDING,
by C. Matson

The features of the Metco Spramold method for the production of inexpensive molds from models of plastics, plaster, wood, glass and even wax are discussed with particular emphasis on the choice and preparation of the model and the reinforcements.

STYLING AND DESIGN OF FIBRE GLASS REINFORCED PLASTICS,
by Fritz Brockmueller

New materials demand consideration of their properties in order to yield the most advantageous results. Therefore, traditional forms should be abandoned and new ways should be entered. This is so much easier since fibre glass reinforced plastics permit the engineer to adapt the tensile, impact, compressive and flexural strengths to his needs and doubly reinforce an article at those points which, according to his experience, are exposed to the greatest stresses. A chart compares the data of fibre glass reinforced polyester resins with those of pure polyester, structural steels and aluminum alloys. Practical advice for good styling and design work is given based on the author's own experience. Close cooperation between the producers of plastics, fibre glass and processors is invited to fill the gap still existing at the present with regard to standardized values for these materials.

BAG MOLDING OF LARGE PARTS
by J. Coudenhove-Kalergi

Equipment needed for and the principle of the vacuüm bag, pressure bag and autoclave molding techniques, as experienced at Omni Products Corp., New York, are described.

DESIGN OF INJECTION MOLDS,
by Hans Gastrow

Details on the design and construction of split follower injection molds for long tubular parts in which core pins are anchored in the plunger of the injection side and outer contours

in split making it possible that such parts be molded in machines corresponding in capacity to the approximate overall piece weight instead of larger machines having an opening stroke between mold halves at least twice the length of the tubular part.

★

GREAT BRITAIN

TRANSACTIONS OF THE BRITISH INSTITUTE

No. 47, January, 1954

Abstracter: Harriman H. Dash

PROTEINS AND PLASTICS, by J. B. Speakman, pp 3-4

This short lecture briefly reviews the recent advances in wool technology, especially those advances prompted by the competition from synthetic fibres. Shortened methods of processing, improved cap-spinning, improved properties by mixed fibres and in situ polymerizations are among the advances discussed.

FLUORINE CONTAINING POLYMERS, by J. Gadsby, pp 5-22

Polymers from fluorinated monomers are comparatively recent introductions. They possess unique properties (primarily high temperature and chemical resistance, and non adhesiveness) suitable for specialized applications. This paper deals with two predominant polymers, polytetrafluorethylene (first produced in the US in 1941 as Teflon, and in England as Fluon) and polytrifluorochloroethylene (produced in the US as Kel-F and fluorothene, and in Germany as Hostaflon and PF). The t.f.e. monomer is produced by pyrolysis of a halogenated methane refrigerant ($CHClF_2$). It is relatively non-toxic and boils at -76.3°C and is polymerized under pressure in the presence of peroxide catalysts. The t.f.c.e. monomer is produced by fluorinating hexachloroethane and is polymerized in a manner similar to t.f.e. A table of properties of both polymers is presented in detail. Some of the more important properties are discussed in relation to molecular structure. Thus p.t.f.e. shows typical characteristics (transition point, cold drawing, etc.) of a crystalline polymer; chemical resistance is a result of the strong F-C bond and the close-packing due to the small size of the F atom; the excellent dielectric properties result from the symmetry of a fully F saturated polymer. Because of its poor flow properties, teflon is difficult to mold by ordinary techniques, hence special procedures, somewhat akin to the techniques applied to powdered metallurgy, are applied. This consists of preforming under pressure followed by sintering at high temperatures (200-250°C). Adequate ventillation must be provided since toxic products may be spit off at these temperatures. This method also has severe limitations with respect to the thickness of molded items. The use of bonding methods, fillers, dispersions are also discussed. The structural differences of Kel-F make it easier to work with this polymer, but its properties likewise suffer somewhat due to the same structural differences. Because of their high cost, use of either material is still warranted only for special applications not satisfied by other materials. Their wider use may be reasonably expected as supply becomes more plentiful with a consequent reduction in price.

SYNTHETIC RESINS IN THE FOUNDRY, by P. G. Pentz, pp 23-42

The resins employed must meet foundry requirements for strong, accurate, and cheap cores and must show a suitable behavior in contact with molten metal. Early problems associated with the use of resins were stickiness, odor, and flow properties. Urea resins were found to be suitable substitutes for the standard linseed oil previously used; these resins had the distinct advantage of permitting a one stage dry and cure, thus saving appreciable core production time and oven space. The use of resins did not fundamentally alter foundry practices until the shell molding (or Croning or C process as it is sometimes known) technique was introduced. This process is bound to have an important influence on the foundry, as well as the resin industry. A brief description of the process, its advantages, and associated problems are presented.

NYLON TEXTILES, by G. Loasby, pp 43-54

Nylon is a condensation polymer belonging to a large group of compounds consisting essentially of methylene groupings joined together with amide groups. A brief description of several of these types is given ((66-Nylon, 6-Nylon (perlon or polycaprolactam), 11-Nylon (Rilsan). Continuous filament or staple fibre is produced by melt extrusion techniques. The properties of the nylons and their use in apparel and industrial applications is discussed in some detail.

EPOXIDE RESINS IN THE PLASTICS INDUSTRY, by W. J. Marmion, pp 55-78

These resins were first produced on a commercial scale in 1950, and have since shown wide acceptance and interest. They are condensation products of epichlorohydrin and diphenylolpropane, and can be further reacted with acid or amine catalysts to yield cross-linked products with very desirable properties (good strength, chemical resistance, adhesion, etc.). Applications include casting, laminating, coatings, adhesives, foams, stabilizers. These are extensively discussed and extensive data is presented.

TRANSACTIONS OF THE BRITISH INSTITUTE

No. 48, April, 1954

THE USE OF PLASTIC BALLOONS IN COSMIC-RAY RESEARCH, by H. K. Heitler, pp 80-86

Polyethylene in .0015 gauge is used for the construction of constant volume balloons. These balloons are superior to latex or synthetic rubber types because of their improved resistance to the intense radiation encountered at high altitudes (up to 20 miles). The balloons are constructed in sections by means of heat sealing. Details of their use, recovery of equipment, and research results are included. Most fruitful results have been concerned with mesons (transient forms of matter) not readily producible in the laboratory.

THE STANDARIZATION OF INSERTS FOR MOLDING, by A. A. Tompkins, pp 87-98

The need for standardization is pointed up by the large number of types used in the molding industry, along with a need to stock large numbers with but small differences. The chief difficulties encountered in the use of inserts are discussed. These include differences in thermal expansion, displacement during molding, insert flash, special inserts. Selection of proper design is emphasized. Salvage and elimination of inserts are also discussed.

SYMPOSIUM ON GLASS-FIBRE REINFORCED PLASTICS, pp 99-128

I. Resins and Techniques, by B. Parkyn. This paper discusses the low-pressure (down to 2 pounds per square inch) and the contact-pressure (below 2 pounds per square inch) laminating techniques. As early as 1942 unsaturated polyesters were found to have the required properties for the low pressure laminating of glass fibres. The major manufacturing techniques discussed include:

(1) Simple mold (contact) method: employs mat or cloth hand lay-up; suitable for large objects.

(2) Flock preform: for volume production of small but deep drawn objects.

(3) Pre-impregnated: This process employs matched metal dies at pressures of approximately 50 psi and yields pin hole free moldings.

(4) Flat contact: good for production of translucent, corrugated sheeting for skylight roofing.

(5) Flexible bag: hot setting resins are employed. Single molds enclosed in a flexible bag yield

(Please turn to page 44)

SECTION NEWS

Edited by

Stanley Bindman

Jamison Plastic Corp.
1255 Newbridge Road
North Bellmore, L. I., N. Y.

Buffalo Section

Richardson Outlines Uses Of Welding Techniques

R. W. Miller

The Buffalo Section of the SPE held their regular monthly meeting November 19 at the Park Lane Restaurant. Speaker for the evening was Mr. L. D. Richardson, Regional Manager and Consultant, Eutectic Welding Alloys Corporation, New York. His topic was "Repair of Molds and Equipment by Welding Techniques."

The program began with a short movie tracing the beginning of Eutectics products from their development stage in Switzerland. After the movie Mr. Richardson enlightened the group by citing specific examples and types of welding points used in repair work.

He pointed out that welding had its crude beginning 3000 years before Christ was born when early man first forged metals. Welding is of three distinct types.

1. Fusion—Melting together.
2. Brazing—Surface adhesion. Brazing material has a lower melting point than the base metal. The material penetrates the pores, freezes and holds.
3. Soldering — Brazing done below 1000° temperature.

It was pointed out that distinct advantages are to be gained from welding at the lowest temperatures possible. They are:

1. Minimize stresses.
2. Eliminate warp.
3. Eliminate changes in grain structure of base metal.

Making a weld involves considerable know how and manipulative skill. The person should consider the following:

1. Choice of metals to do the job.
2. Design of weld.
3. Base metal of material to be welded.
4. Effect of heat on metal.
5. Affinity of welding material.
6. Selection of a material that will provide desirable properties after weld is made. Manipulative skill would require that the proper process and procedure be worked out.

Mr. Richardson pointed out that the type of welding rod used should be selected to match the type of working the metal to be welded received during fabrication. These classifications are as follows:

Oil Hardening	OH
Water Hardening	WH
Air Hardening	AH
Hot Working	HW
High Speed Steel	HSS

The above classification of rods are engineered to weld the type of material that the classification describes.

Mr. Richardson stated that any tool can be welded and only the economies govern the feasibility. He closed his talk by showing slides and describing techniques found successful for forming joints. Some of these are listed below.

1. For bonding to Meehanite use #25 rod and then coat with harder material.
2. Use 1850 rod on beryllium copper.
3. Use 196 rod on Kirksite.
4. Use 68 rod on strain bars on injection molding press.
5. For filling large voids butter the joints with material and then fill in. Buttering results quite frequently in forming stress free joints.
6. A technique found successful in certain applications is to place a copper shim between materials. The copper shim will act as a shock absorber.

Mr. Richardson and his associates answered questions after the regular meeting was concluded. It was pointed out that the Eutectic Welding Alloys Corporation is ready to provide technical assistance wherever required.

SET SAIL FOR ATLANTIC CITY

Cleveland-Akron

Speaker Discusses Salvage of Dies

R. M. Hershey

Approximately 80 members and guests of the Cleveland-Akron Section turned out on Monday, Nov. 8th to hear Mr. L. D. Richardson of the Eutectic Welding Alloys Corp. speak on "The Salvage of Dies and Equipment Used in the Plastics Industry."

Mr. Richardson reviewed the welding of metals in great detail and also discussed soldering and brazing. Reference was made to specific application of various welding alloys for the repair and salvage of dies and other equipment. The excellent discussion was illustrated with colored slides which showed several successful applications of the welding alloys. The type of welding alloy, the methods of welding, and all critical points involved were reviewed for each application.

Following his talk, Mr. Richardson distributed several brochures detailing methods of welding and die repair.

At the dinner meeting which preceded Mr. Richardson's talk, it was announced that the annual Cleveland-Akron Section SPE Christmas party would be held at Aurora Inn on Friday, Dec. 10th. The new directors and officers for 1955 will be announced at the Christmas party.

The next regular meeting of the Section will be held on Feb. 14, 1955.

It was also announced at the meeting that committee chairmen have been appointed for the 1956 Technical Conference and that active planning for the Conference is underway.

Golden Gate

Rockwood Speaks At Joint Meeting

T. V. Malianni

On Tuesday, November 23, The Society of Plastics Engineers and The Society of Plastics Institute held a joint meeting so that both organizations could benefit from a program that was of interest to all members of the plastics industry.

They joined for dinner at the Colonial Manor. Business announcements were made during dinner in order to give the speaker of the evening as much time as possible for his talk. Selected speaker was Mr. Robert Rockwood of the Barrett Division, Allied Chemical & Dye Corp. who gave a very interesting talk on "Our World of Color" and then supplemented his remarks with an illustrative movie.

Philadelphia

Hellyar Reviews High Rate Of Growth In Plastic Industry

Samuel H. Greenwood

The Philadelphia section held its October meeting and dinner at the Franklin Institute.

The speaker of the evening was Mr. Edward V. Hellyar, assistant sales manager of the Styrene molding materials, Plastics Division of Monsanto Chemical Co. Mr. Hellyar has been in the field selling Monsanto's products from their Plastics Division and has also served as acting sales manager for Monsanto's Sheets Products Division.

Mr. Hellyar's talk involved a brief review of the plastics industry with particular emphasis to its fantastic rate of growth. He also gave some figures which attempted to outline the growth potential for this dynamic industry. The main theme of his talk was marketing and the place that this technique played in attaining the goal of the plastic industry.

Mr. Hellyar noted that the average growth in the plastics industry had been at a rate of approximately 10% as compared to the overall national economy growth figure of 3%. In 1953 the sales amounted to two billion, six hundred million pounds of material. He then briefly covered the eight primary materials, noting the poundage that had been sold in 1953 and also listed the main applications for each of the materials in question. The eight were: styrene, vinyl chloride, vinyl butyrate, phenolics, urea & melamines, polyethylene, cellulosics, and nylon.

Mr. Hellyar feels that better marketing practices are essential for the growth and continuing betterment of the plastics industry. He further noted that there was a great need for a steady flow of new and improved procedures and processing. It was the task of the marketing services to create sales and product ideas. A dynamic and aggressive marketing program is essential to the plastic industries, Mr. Hellyar stated.

Marketing services have been greatly expanded as noted below.

1. Technical services — technically trained men are now available to aid the customers.

2. Advertising and sales promotional programs are now carefully integrated to build up a demand and also to create customer acceptance.

3. Public service films — well planned films that are now available for use on TV, at clubs, and at schools to educate the public on the use and acceptance of plastics.

4. Public relations efforts — plant visitations, panel discussions, and so forth.

5. Color styling — aiding the customer in selection, design and ultimate use of their products.

6. The broadening use of statistical quality control — Mr. Hellyar noted that Monsanto had a booklet on this growing technique to aid the plastic molders and fabricators.

7. Application research — this work is to aid fabricators to design for sale their products with an emphasis upon the proper plastics for the particular application being considered.

Don't forget about SPEAS '55. The whole Philadelphia Section, as well as your national members, are busily laying the groundwork for a bang-up meeting in Atlantic City.

New York Section

A. M. Merrill

The November meeting of the New York Section took the form of a joint meeting with the Newark Section and the ASME Metropolitan Section at the Commercial High School, New York City, on Nov. 15. The meeting itself was a review forum which concluded the nine-week plastics symposium organized by the ASME Section in conjunction with the SPE groups, and featured a plastics exhibit sponsored by the latter.

The forum was conducted by J. H. Du Bois, Mycalex Corp. of America, and began with brief talks on the following subjects raised at previous symposium sessions: shell molds and other foundry applications for resins — George Rhine, "Plastics World"; isocyanate foams — George Sprague, Sponge Rubber Products Co.; plastics in orthopedic devices — Isaac Kinsey, Owens Corning Fiberglas Corp.; resorcinol resins — J. W. LaBelle, Foster Grant Co. and SPE national president; and plastic pipe markets and applications — H. J. Weber, Rotuba Extruders, Inc. A spirited discussion followed the talks as the meeting was thrown open to questions from the audience which numbered more than 300 persons.

The exhibit consisted of displays by 36 plastic materials and processing companies illustrating their products, operations, and fields of application. Arrangements for the displays were handled by William Lewi, Dusal Tool & Mold Co., and exhibiting companies were as follows: American Cyanamid Co.; Bakelite Co.; Balsa Ecuador Lumber Corp.; Barrett Division, Allied Chemical & Dye Corp.; Bassons Industries Corp.; Bigelow Fiber Glass Products Division, Bigelow-Sanford Carpet Co.; Boonton Molding Co.; Crest Chemical Industries; E. I. du Pont de Nemours & Co.; Eastman Chemical Products, Inc.; Empire Brushes, Inc.; Ethylene Chemical Corp.; Foster Grant Co.; Garfield Mfg. Co.; General Electric Co.; Gering Products, Inc.; Insulating Fabricators, Inc.; Irvington Varnish Co.

Also M. W. Kellogg Co.; Lunn Laminates, Inc.; Mack Molding Corp.; Molding Specialists, Inc.; Monsanto Chemical Co.; Mycalex Corp. of America; Naugatuck Chemical Division, United States Rubber Co.; Nylon Molding Corp.; Owens-Corning Fiberglas Corp.; Parker-Kalon Division, General American Transportation Corp.; Plax Corp.; Progressive Industries, Inc.; Pyro Plastics Co.; Robinson Plastics Co.; Rotuba Extruders, Inc.; Shaw Insulator Co.; Shell Chemical Corp.; and Ullman Associates.

A total of 18 new members was added by the New York Section during November. These new members are: J. J. Begley, market development manager, Celanese Corp. of America; H. M. Belmuth, district manager, St. Regis Paper Co., Panelyte Division; R. C. Brumberger, chemical sales manager, Nuodex Products Corp.; Salvatore Cicio, Robert Ernst, manager of plastic materials dept., Omni Products Corp.; A. A. Evans, designer, Vacuum Forming Corp.; R. A. Grayson, sales manager, Marblette Corp.; G. B. Herblin, president, Herblin Corp.; Max Hilrich, research director, Marblette Corp.; Xavier Kollmeier, plastics mold designer, International Business Machines Corp.; M. L. Levin, owner, Monte L. Levin, Inc.; C. A. and E. G. Pamatat, partners, United Mask & Novelty Co.; George Pandolfo, plant superintendent, Arliss Co., Inc.; K. G. Roberts, sales rep., Plastic Materials, Inc.; H. B. Sindel, secretary, Gibson-Thomsen Co.; R. C. Wadsworth, mold designer, IBM; and B. L. Wallis, assistant research director, Marblette Corp.

Necrology

Deane C. Severance

Deane C. Severance, past Chairman of the West Coast Section of the Society of the Plastics Industry, died at the age of 55 of a heart attack November 14th at his home in Whittier, California. He was the founder of Lee Deane Products, Inc., a plastic molding company. He was a graduate of the University of Illinois and had attended the University of Wisconsin. He served in the Marine Corps in World War I. Mr. Severance leaves his widow, Jennie; his mother, Mrs. Gertrude L. Byrum, a daughter, Mrs. Susanne Rodgers; a brother, Guy L. Severance, and two grandchildren, Margaret and James Rodgers.

Milwaukee

'Hydrocal' Benefits Listed By Young

Marvin C. Stowe

One hundred and fifty members and guests attended the Milwaukee section's November 9th meeting which was held in conjunction with the Plastic Tooling Seminar sponsored by Owens-Corning Fiberglas Corp.

Mr. M. K. Young, assistant production manager of the United States Gypsum Co. was the guest speaker for the evening. He was introduced by Mr. M. Lanza, director of merchandizing, U. S. Gypsum Co. The topic was "Hydrocal Tooling in the Plastics Industry."

Mr. Young first described the role of plastic tooling in our material economy. He then showed how gypsum cements could be extremely helpful in production of plastic tooling. He showed that gypsum cements could be used to create economic advantages in preparation of plastic tools since their use symplified manufacturing operations. It was also brought out how gypsum cements differed from ordinary plastic, and that these differences made gypsum cements valuable tools for the toolmaker.

The main advantages of the "Hydrocal" gypsum cements are:

1. Low and controlled expansion during curing. Ordinary plastic expands approximately 1/32" per foot. The "Hydrocals" have a controlled expansion that can be varied from .005" per foot to as high as 1/4" per foot where necessary.
2. Improved physical properties
   A. Greater hardness
   B. Greatly improved compressive strength — up to 11,000 pounds per square inch for Hydrostone.
3. Longer setting time — permitting longer working time prior to setting.

A sound-slide film was then presented showing the various methods useful for handling plastic materials. After discussion of this film and an actual demonstration of how a gypsum cement should be used, Mr. Young showed another group of slides illustrating how "Hydrocal" was used to advantage in preparation of the original body pattern for a reinforced plastic bodied automobile.

His demonstration was a valuable part of the program in demonstrating actual working conditions, proper mixing and blending and illustrating the proper handling techniques.

A discussion of the various types and grades of "Hydrocal" available followed, with Mr. Young explaining the advantages and uses of each grade.

In concluding the meeting complete literature on all of the "Hydrocal" and "Hydrostone" materials produced by the United States Gypsum Co. was distributed to all those present.

Rochester Lists Section Officers

President, Gerald Delaire; Vice-President, C. Burton Wing; Secretary, Herbert B. Collins, Jr.; Treasurer, George Erdle; National Director, Gerald Delaire (1954-56); Past President, John H. Beach.

Directors are Jack S. Dabbs, George Erdle, Francis W. Reynolds, Joseph Grabowski, Charles E. Lennon, Floyd Redman, Herbert B. Collins, Jr., Victor F. Serrell, C. Burton Wing.

Committee chairmen are: **Program,** Jack S. Dabbs, C. Burton Wing, Ass't.; **Membership,** Albert F. Patterson; **Housing,** George A. Hayslip; **Publicity,** Norbert G. Zink, **SPE Journal,** Waldo B. England; **Attendance,** Charles E. Lennon; **Auditing,** George A. Neward.

Toledo

Section Visits Owens Brush Co.

R. E. Dunham

On September 29, the Toledo Section was privileged to visit the Owens Brush Co. in Toledo. This firm is one of the largest manufacturers of brushes in the world and specializes in tooth brushes. Injection molding of the handles is the first step in the making of most brushes. Cellulose acetate butyrate and methyl methacrylate are the materials most widely used. Owens Brush also injection molds polyethylene items which supplement the brush line.

The Toledo Section was fascinated by the operation of setting of the bristles. Nearly all the bristles used at Owens Brush are made from nylon. The machines operate very fast — drilling holes and inserting the bristles at high speed. The packing department has been recently modernized and a diversified number of packages are packed. The trip was very educational for those who attended.

An unusual molding operation was observed and an interesting talk and demonstration was given the Toledo Section by Mr. Charles Dimmer, member of the Toledo Section. The meeting was held at the Dresch Laboratories which were visited. The Dresch Laboratories are manufacturers of dentures and use Jectron denture resin in making dentures. These dentures are made by injecting plastic softened by heat into a ceramic denture mold which contains the teeth. A special small molding machine is used to do this.

Jectron denture resin is a compound of polystyrene which has been developed and manufactured expressly for artificial dentures. The development of Jectron began in 1940, and was culminated by a perfected resin in 1950. Along with the resin a molding machine was developed and the two were placed on the market March 1, 1951. Jectron was certified by the American Dental Association in Dec., 1953.

Jectron is supplied as rods about six inches long and one inch in diameter. This material has been formulated by a company that formulates polystyrene and the rod is prepared by a custom extruder. This rod is heated to molding temperature. The denture mold is placed in a fixture heated for drying, and placed in the base of the machine. The softened material is placed in the cylinder of the machine and injected into the mold. After a few minutes the mold is removed fro mthe machine, and denture removed, cleaned, and polished.

Jectron is claimed to have a number of advantages over other denture materials. There isn't any processing shrinkage with Jectron except the three-fourts of one per cent due to thermal contraction. Other materials shrink as much as 7%. Expansion of other denture materials in the mold can cause distortion of the cast and investment. This does not occur with Jectron. There is no swelling due to absorption of water with Jectron.

Jectron is much stronger than other denture materials and has a transverse strength of 14,000 psi. The flexure fatique at 2500 psi is beyond 4,000,000 flexures. The hardness is beyond Rockwell M 88 and Heat Distribution is 231 to 239 degrees Fahrenheit. The color is stable and the material is non-toxic.

(Continued from page 41)

moldings with two good surfaces.

(6) Vacuum molding: yields pin hole free moldings. Resin is drawn in to mold cavity by means of vacuum. Atmospheric pressure holds mold halves together until curing is completed.

Factors affecting curing, time, maturing, rigidity, and other properties of the finished laminate are also discussed. A section on availability and cost of materials is also included.

II. Products and Applications, by A. M. Dobson. This paper discusses the manufacture of staple-fibre and continuous-filament glass yarn, glass cloth, glass mat, and glass roving. Several tables and graphs concerned with the properties of reinforced plastics are presented, and the effect of cloth construction and surface finish is discussed.

Miami Valley

Latest Vacuum Forming Developments Discussed

Martin H. Kasch

The Miami Valley Section's October 14th meeting heard Mr. Sanford Zimmerman of Vacuum Forming Corporation of Port Washington, New York, one of the leading authorities of vacuum forming of Thermoplastic sheet. The dinner meeting was held at Eaton Manor in Hamilton, Ohio and was attended by 64 members and guests.

Mr. Zimmerman in his talk covered the latest developments in this controversial field of vacuum forming. He covered the various techniques and machines being used to form a variety of plastic sheet materials. Samples and slides were used in connection with his talk.

Members and guests from 25 firms participated in the question and answer period that followed.

The November 11th meeting was a plant tour of Cincinnati Milling Machine Company in Oakley, Cincinnati. Approximately 75 members and guests were escorted by very capable guides. After being shown the replica of the original Cincinnati Milling Machine factory (founded 70 years ago) with some of the original equipment, the group were guests of C.M.M. at their plant dining room.

After dinner the group was taken to the Auditorium for a picture show titled "Dragin." The picture depicted the costly operation of old or antique machinery, whereas new machinery produced better parts and at higher production levels.

A short business session then was held for the purpose of making some announcements. The election of the new Directors was announced naming Ray Adams of Adams Plastics Products of Cincinnati, Paul Caldwell of Plastics Research Products Company of Urbana and Martin Kasch of Kurz-Kasch, Incorporated of Dayton. The retiring Directors are Richard Bice, Formica Corporation, Joe Merke, Plastic Moldings Corp., and John R. White (deceased) Buckeye Molding Company.

The annual Christmas party will be held at Hartwell Country Club at Hartwell (near Cincinnati) December 4th.

The tour continued through departments where they build the Cincinnati milling machines and through departments where actual demonstrations were being made. The 3-dimensional duplicators were at work cutting mold cavities. The "Hydro-form" process for drawing operations on sheet metal was shown. Flame hardening process for hardening gears, pinions, etc., was demonstrated. Equipment for testing life of tools, wear on machines, etc., was very interesting to the group.

During the course of the tour other machines were also shown as lathes, drill presses, grinders, etc.

Thanks to Al Plimmer for showing us a good time.

The Directors, including the retiring members and the new members, met November 18th to elect new officers and make plans for the Christmas party and the coming year. The new officers for 1955 are, Joe Overwein, of Inland Mfg. Division G.M. Corp., President, Jack Barnhiser, N.C.R., Vice President, Martin Kasch of Kurz-Kasch, Inc., Secretary and Lloyd Larrick, Recto Molded Products, Treasurer.

Central Ohio News

William L. Croll

The October meeting of the Central Ohio Section of The Society of Plastics Engineers was held at The Colony Restaurant on West Broad Street in Columbus, Ohio on October 19, 1954.

A short business meeting was held immediately following the dinner at which time the minutes of the previous meeting were approved as read. The November 16th meeting of the CTC at The Southern Hotel in Columbus was announced by Mr. Nixon.

It was also announced that our next meeting will be a joint meeting with the Southeastern Ohio Section in Newark, Ohio on Thursday, November 18th. Mr. Homer Winkler of Battelle will speak on Polyethylene in Printing. It was decided that because of the Christmas rush there would be no meeting in December. The January meeting will be held January 25th and will be a trip through The Westinghouse Plant.

The Section then received a very interesting talk by Mr. Charles Lucks of Battelle Memorial Institute concerning the Central Ohio Technical Foundation. Mr. Lucks showed photographs of the building and facilities of the Cleveland, Cincinnati and Detroit meeting places. These pictures were looked at rather enviously by the members of the Section and after the pictures, Mr. Lucks explained the desire of Columbus to have such a place. Subscription cards were then passed out to the members.

Following this, we had a movie entitled "Futures Unlimited" presented by Rohm & Haas. This movie showed fiberglas molding in The Zenith Plastics' Plant in California. Mr. William E. Wirsch of Rohm & Haas also discussed further the applications and usages of polyester resins in fiberglas molding and answered the questions of the group.

MOLD DESIGN • **PRODUCT DESIGN** • **CONSULTATION** • **CUSTOM MOLDING**

Phone—Fort Wayne, Ind.
New Haven 5273

PRIBBLE PLASTICS PRODUCTS, INC.
(Formerly Barrier-Pribble & Co., Inc.)

554 Eben St.
New Haven, Ind.

Dear Friends:

Seven years have passed since that Jan. 1 day in 1948 when we first offered our services as an organization. We have been pleased with the many friends we have made since then. I think nearly all of our business relations have been good and, of course, we regret those few instances where we failed to completely satisfy. We have that warm feeling that comes from having tried and succeeded. You know what I mean because you too, have had that feeling when some knotty problem was solved by cooperative effort.

Christmas Day comes once a year. Is there any reason why each of us should wait for this time of year just to work for "Peace on Earth to all men of Good Will"?

Seasons Greetings to all

Wayne I. Pribble

WAYNE I. PRIBBLE

R.I. And S.E. Mass.

Injection, Extrusion Of Kel-F Outlined By Jules Jupa

Stephen Kalarian

On Nov. 16th over 40 members of the Rhode Island and Southeastern Massachusetts Section of SPE turned out to welcome a familiar name in the plastics industry—Jules Jupa. Being technical field representative of the M. W. Kellogg Company, Mr. Jupa was well qualified for his after dinner talk on "Injection and Extrusion of Kel-F." He unfolded his story by giving a brief history of the background of this material. It seems that this plastic was born out of necessity of the demands of World War II. An organization called the Kellex Corporation designed and built some K-25 gaseous diffusion plants. One requirement for their equipment was a plastic material to withstand highly corrosive chemicals and radio active materials. The search for this material was turned over to Dr. W. T. Miller of Cornell University. Under Dr. Miller's guidance polytriflurochloroethylene — Kel-F for short—was developed. Since Kellogg was the parent company of the Kellex Corp., commercial production of Kel-F was started by Kellogg soon after World War II.

"Kel-F" is a true thermoplastic material and hence lends itself readily to injection molding. Conventional equipment can be used with slight modifications to compensate for some of the unique properties of this plastic. Higher cylinder temperatures in the order of 500 to 570°F are recommended. However, too high a temperature coupled with allowing material to stay too long in the cylinder, will induce degradation or thermal breakdown of the plastic. Extreme care should be exercised in keeping the material clean. Being electrostatic in nature, it readily attracts dust particles from the air, hence contamination of molded parts. The dies should be made from dura-nickel or chrome plated carbon steels. Die temperatures of 300 to 310°F are being used. Molding cycles from 30 seconds to 2 minutes are normal depending on the size and cross section of the piece. Since some crystallization of the material is brought about by slow cooling of Kel-F and in order to avoid strains and encourage high physical properties, injecting this material through a long system of sprues and runners is not recommended. Rather the shorter the path of the hot material to the cavity, the better. Experimental work has been done on a hot runner system whereby hot material is introduced into a reservoir prior to being transferred into the cavity. The path between hot reservoir and cooler cavity is kept as short as possible, hence reducing left over scrap and avoiding crystalline material from entering the cavity.

In extruding Kel-F as in injecting it, nothing special is required except equipment adequate to handle the higher temperatures required. The liner, screw, and die should be made from stainless steel or chromium plated parts. Dies should allow material to flow through in thin layers and the high temperature zone should be limited to the exit end of the die. Generally the high melt viscosity of Kel-F at flow temperature is sufficient to induce back pressude which assures adequate mixing of this material. This forced flow also reduces pulsation. Take off belt should be able to withstand 400 to 500°F. As material emerges from the die, cooling is by atmospheric air or high boiling liquids. Rapid cooling from the amorphous state to crystalline state causes hardening of the profile and sometimes voids due to severe internal shrinkage.

Mr. Jupa ended his story by enlightening us on some of the outstanding properties of this material. It has excellent chemical inertness, that is, it is impervious to the action of corrosive chemicals and resists most organic solvents. Its physical properties are very good and light transmission properties have exceeded 90%. It functions satisfactorily at -320°F to 390°F. Volume resistivity is in the order of 1.2×10^{18} while arc resistance is greater than 360 seconds with no traces of carbonization between the electrodes. Price is in the vicinity of $10/lb.

After distributing some Kel-F parts for inspection, Mr. Jupa answered several questions proffered by the group.

At the outset of the meeting, President Roy Slipp announced the election of new members to the board of directors as follows: Emile Kleiner, G. E. Taunton, Mass.; Edward I. Rose, Plastic Engineering Co.; Stephen Kalarian, Molding Corp. of America.

The next topic of the meeting was presented by Bob Johnson, national director. He stated that the title "Professional Member" in SPE is misleading since in many states the title professional implies passage of state examinations in various technical fields. It was the concensus of the section to favor a change from the word "professional" to "senior" member in regards to this particular rank in the SPE member classifications.

Prior to departure two door prizes were drawn. Joseph Allard of Royal Electric Co. won a canister set donated by Bill Monahan of Dow Chemical Co., and Jules Jupa, our guest for the evening, won an embedded cigarette lighter contributed by Bob Johnson of Monsanto Chemical Co.

After the regular meeting a special meeting of the board of directors was held to elect next year's officers. The slate of officers elected is as follows: Emile Kleiner, president elect, G. E. Taunton, Mass.; Myles Powell, vice-president elect, E. I. DuPont de Nemours Co.; Stephen Kalarian, treasurer elect, Molding Corporation of America; Hugold Anderson, secretary re-elect, Hugold Anderson, Inc.

It is the general opinion of the section that the outgoing officers did a splendid job of organization and administration. They are to be commended for a job well done.

Four R.I. and S.E. Mass. Stalwarts

Left to right are: Casimer Plasewicz, Roy Slipp, Bob Johnson, and Ian Robertson. Photo was taken at October meeting of the Section.

Blueprint accuracy is yours with 'TRU-CAST'

MANCO

BERYLLIUM COPPER CAVITIES AND CORES

Write today on your company letterhead for your FREE copy of the 48-page, illustrated new 'Tru-Cast' Handbook.

MANCO PRODUCTS, Inc.
2401 Schaefer Road, Melvindale, Mich.
Telephone — Detroit: WArwick 8-7411

Newark

Members Hear Nemeth; View Polyester Film

D. J. Mullins

J. G. Nemeth of Insulating Fabricators Inc., East Rutherford, N. J., presented a discussion on fabricated plastics at the November meeting of the Newark Section.

Mr. Nemeth explained that the basic forms of most plastics laminates are sheets, tubes and rods of which none are used in the exact size manufactured. Fabricating must be performed somewhere along the line of laminator, independent fabricator and ultimate manufacturer. Separating his topic into thermosetting and thermoplastic plastics groupings, Mr. Nemeth discussed the various factors of machining and the reactions of the respective plastics within each group to machining operations. Mr. Nemeth explained that the principal problems which determine machining techniques for plastics are:

1. Thermal: All plastics are heat insulators rather than conductors, and in addition can withstand only moderate temperatures without deteriment.
2. Abrasion Nearly all plastics are abrasive, with a tendency to dull cutting tools much more quickly than metals. Because of the abrasive nature of nearly all of the plastics, it is necessary to provide a very refined and complete dust and chip collecting system. In addition to a central system, it will be found essential to provide industrial vacuum cleaners for certain operations.
3. Density: The low density of plastics compared with metals permits faster machining and the use of lighter duty machine tools.
4. Homogeneity: Some plastics, notably the laminates, are not homogeneous with different properties lengthwise and crosswise of sheet. Many other plastics show a definite "grain" structure.

While distributing samples of machined pieces to the audience to illustrate his talk, Mr. Nemeth elaborated on the procedures for shearing, punching, sawing, drilling, lathe turning, screw machining, milling, routing, shaping, engraving, marking, sanding, buffing, tumbling, post forming, printing circuits, fungus proofing, annealing and cementing thermosetting and thermoplastic types of plastics.

Following Mr. Nemeth's talk, a technicolor film entitled "The Polyester Resins" was presented through the courtesy of the Rohm and Haas Co. The film which was made primarily at the Zenith Plastics plant in California centered on the use of polyester—fiberglass laminates in U. S. Air Force aircraft. It was emphasized that reduction of weight, high tensile strength, lower tool costs, elimination of corrosion, etc. had placed polyester-fiberglass laminates on the top of the preferred material list for such military aircraft parts as tail assemblies, radar domes, etc.

Further information on the proposed certificate program of training in Plastics Engineering Technology to be given at the Newark College of Engineering in conjunction with the Newark Section, SPE, was announced. Two courses, one on compression molding and the other on injection molding will be the initial offering for the January 1955 term. Response to these two courses will serve as a guide to the instituting of a complete outline of courses. A complete course is tentatively planned for the Sept., 1955 term.

Table favors for the meeting were donated by Thomas Manufacturing Co., Newark, N. J. Door prizes were donated by the Rohm and Haas Co.

Southern

Mighton Speaks

C. Veasey LeCraw

The Southern Section had as its speaker for the November meeting Mr. J. W. Mighton who is head of the sheeting section of the Dow Chemical Company's Plastic Technical Service. Mr. Mighton spoke to the group on "Vacuum Forming of High Impact Polystyrene Sheet."

Mr. Mighton has been with the Dow organization since 1946. Most of this time has been spent in handling development work on materials and equipment for vacuum forming of plastic parts. Mr. Mighton is a graduate of Carnegie Institute of Technology.

Vacuum forming technique was demonstrated on portable equipment which was set up at the meeting. Mr. Mighton also showed slides of typical plant equipment and processes used in this field.

Some of the advantages of vacuum forming of high impact polystyrene which Mr. Mighton pointed out are:

(1) Low cost equipment, tooling, and raw material.
(2) High speed production (25-40 second cycles).
(3) Scrap can be reclaimed.
(4) Low specific gravity material.
(5) Material does not spring back.

For the regular December meeting the section will have a variety night to which the members and their ladies will be invited. Prior to the meeting, the board of directors will hold an election of officers for the coming year. results of this election will be announced at the meeting.

You can be sure

you're planning your production properly if you've considered the advantages of

Marblette Plastic Tooling Resins

which can speed designs from drawing board to production run, require no heavy equipment investment or highly skilled labor, facilitate pilot runs and design changes, and

will save you up to 70% in time and up to 80% in cost

in making stretch dies, draw dies and panels, match dies, jigs, fixtures, patterns, models, prototypes, core boxes, plating shields, bag and contact molds, latex dip production forms, molds for fibrous glass lay-up, spray-metal backing, vacuum-forming, and electro-forming, and other types of tools and dies.

The versatile yet specialized liquid epoxy and phenolic resins developed by Marblette fit into your production picture. Convince yourself—see how they can give you increased economy and efficiency—use the handy coupon below for resin samples, technical data, a phenolic data folder, an epoxy data folder, and a conversion computer that shows at a glance how much resin to use for casting any size product or part.

Marblette

The Marblette Corporation
37-25 Thirtieth Street
Long Island City 1, N. Y.
We are interested in plastic tooling for

.....

Please send us free
☐ Technical Literature
☐ Phenolic Data Folder
☐ Epoxy Data Folder
☐ Conversion Computer

Name .....
Title .....
Company .....
Address .....

Philadelphia

Need for Plastics Data Is Stressed By John LaBelle

H. C. Colby, Jr.

Approximately ninety members attended the November 23rd meeting at the Franklin Institute. John LaBelle, president of SPE was the main speaker. He was introduced by William Bracken of the Hercules Powder Co.

Mr. Bracken gave an extremely interesting report on the intensive preparation on the Atlantic City S.P.E. Conference. He particularly commended the excellent work Jerome Formo of the Minneapolis-Honeywell Company and his committee had done on obtaining speakers for this Conference. There are now a total of 59 papers which will be given at three concurrent sessions during this Conference.

A general breakdown of these papers is as follows:

Of Interest To	Number of Papers
General	28
Injection Molders	19
Resin & Material Manufacturers	18
Mold Makers	14
Reinforced Plastics Molders	13
Fabricators	13
Educational Testing & Research	13
Compression Molders	11
Customer & Consumers	11
Vacuum Molders, Film & Sheet	8
Machine & Equipment Manufacturers	8
Laminators	6
Extruders	6

Mr. Bracken noted that they have now received 35 company registrations and 320 reservations. He estimated that there will be 2500 men and women present at the Atlantic City Conference. Preliminary survey indicates that 500 women will be attending this Conference.

The principle speaker for the banquet will be Brig. Gen. C. J. Bondley, Jr., of the United States Air Force Strategic Air Command. It was noted that his talk will be devoted to the Strategic Air Command operation. It was also announced that Mr. John LaCerda will be the speaker at the Friday noon luncheon. Mr. LaCerda is presently President of the Poor Richard Club and has done extensive work as a foreign correspondent. He is a well known world traveler and public relation expert who will have a message of real interest to all of us.

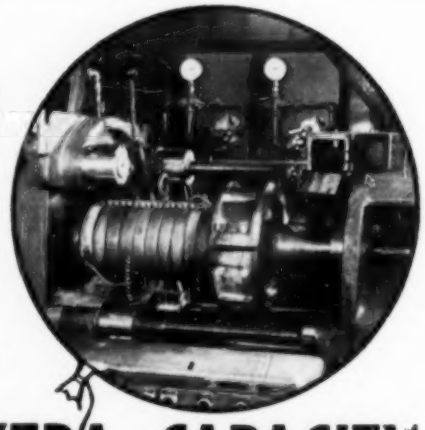
Mr. Bracken also mentioned that considerable thought had been given to a fine program for the ladies. There will be special tours of the Lenox China Factory at the Pomona, N. J. plant, a fashion show presented by the Moore Institute of Art, and an afternoon tea followed by a musical program. Tours have also been arranged of the Chalfont-Haddon Hall Hotel's kitchen and bakery.

Bill Bracken then introduced his good friend, John LaBelle, President of the S.P.E. and Director of Sales, Petrochemical Division of the Foster Grant Company. Mr. LaBelle commented on the splendid work that was being done in preparation for the Atlantic City Conference, and observed work that was being done in preparation for the Atlantic City Conference, and observed that this coming Conference certainly promised to be the finest in the history of the S.P.E. He then referred to the splendid report prepared by Business Week in the April 10th, 1954, issue on the tremendous growth of the plastics industry. This report gives a splendid picture of the growth of our industry from 1922 through 1953, and LaBelle emphasized the precipitous curve of growth that the plastics industry has experienced. He noted that 5,000 U. S. companies now employ over 200,000 workers where plastics manufacture is their main productive effort. There are 71 colleges throughout the country that are giving courses in plastics. The F-84 Thunderjet plane now uses over 225 parts that are produced from various plastic materials. Based on the growth curve over the past few years, estimates are that there will be 6½ billion of plastic materials in 1960.

In conclusion, John LaBelle noted that there was a great need for strengthening our national position as this tremendous growth definitely would encourage certain parasitic action. He emphasized the need for more complete data on plastic characteristics. He also stressed the need for more young men to be trained to assume positions of responsibility in our industry. There is presently a lack of qualified technical men to carry the responsibility of proper application in industry such as aircraft, automotive, electrical and other fields. It was also pointed out that there was some danger of absorption, and an example was here given of the steel industry considering entering the plastic pipe market.

Program for SPE's 11th
ANNUAL TECHNICAL CONFERENCE
is on page 28-30

LICK RISING
INJECTION MACHINE COSTS
INSTALL AN



IMS EXTRA CAPACITY HEATER • ON YOUR PRESENT MACHINE ON YOUR NEXT NEW PRESS

Step Capacity Up 25-50%... Save on New Machine Cost . . . Gain Extra Production!

Stock Model 12-14 oz. 11,000 watt Superheater for Reed 8, ...$1095.00

We Design and Build

IMS LEAKPROOF SUPERHEATERS for REED • WATSON • HPM • LESTER etc.

INJECTION MOLDERS SUPPLY CO.

3514 LEE ROAD | WYoming 1-1424 | CLEVELAND 20, OHIO

Detroit

Silk Screening On Plastics Is Described and Methods Detailed

J. H. Kuhn

The Detroit Section of the S.P.E. met on November 2nd, 1954 at the Rackham Memorial Building in Detroit.

The President, Carl Whitlock, introduced to the 53 members and guests two special guests for the evening—Bill DeGalan, former President, and S.P.E. Charter Member and Life Member, Bill Hoey.

Mr. Harold Beaver of the Big Beaver Manufacturing Company delivered a well-planned address on silk screening on plastics with particular emphasis on the method in which silk screen production is utilized in the process of sheet plastics into three - dimensional displays which have come to the front very much because of their usefulness and effectiveness in producing eye-appealing and punchy displays. The three processes of silk screening, (1) printing from type, (2) printing off a roll and (3) printing through a stencil, were described to the audience unfamiliar with the process. Various samples of three-dimensional decorative plastics were exhibited. They were all vacuum formed sheets that had been silk screened before vacuum forming. Hand-painting of these three-dimensional surfaces would be very costly and therefore are silk screened prior to forming. Vacuum forming of plastics is the process in which a thermo plastic sheet is heated to a limp sheet, approximately 300°, placed over a mold, at which time the air is evacuated from the mold letting atmospheric pressure push the material into all the cavities of the mold, then cooled back to its rigid state and removed from the mold.

Mr. Beaver explained that silk screening must be done on a level surface. Therefore after the vacuum formed molds are made, two plastic sheets of the grade and gauge which will be used on production are formed. These pieces are then hand-painted for color approval and eye appeal. The various colors on the formed pieces are outlined in pencil or ink for color separation. The sheet is then put back into the forming machine and heated slowly until it returns to its natural flat form, which results in a flat form with distorted art work. Silk screens are then cut, one screen for each color, and the production run is printed—color after color. When these sheets are dry, they are then vacuum formed and the finished part is then in its three-dimensional state.

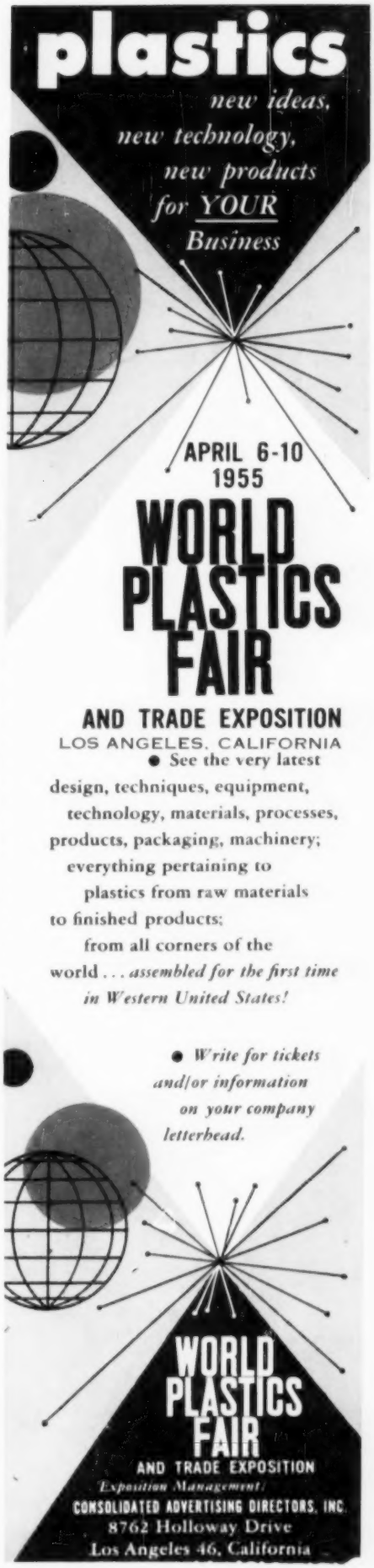
Mr. Beaver discussed the types of material used for printing, which include lacquers, enamels, inks and dyes, which are formulated especially for the different type plastics used, such as acrylics, vinyls, acetates, and styrenes. Mr. Beaver stressed the importance that materials and the particular lacquer, enamel, ink or dye used must be tested for heat, weatherability, adhesion and crazing. The various specialists manufacturing these coloring materials can be relied upon for producing the formulations and for running weatherometer and fadeometer tests. However, Mr. Beaver recommends the individual using these products to still run his own tests.

Samples were illustrated showing a molded candle which was a 3-color screened job, silk screened green, then red, then yellow, with the tip of the candle and areas around the wax air brushed with a Paasche gun.

Mr. Beaver stated that in pre-decorating and vacuum forming of sheet plastic, there are certain limitations as to the holding of registration. As far as the actual screening is concerned, this can be done very accurately but when the part is vacuum formed there are so many variables that it is not always possible to lay the color in perfect registration with the mold. Some of these variables are sheet tolerance, heat control of the sheet, heat control of the mold, thickness of paint film, and the color of the paint. Design plays an important part in compensating for these variables.

Mr. Beaver went on to discuss other methods of decorating on plastics which included:

(1) Offset printing with dyes on flexible material such as polyethylene, flexible acetates and vinyls. This is a continuous process where the material is fed into the printing machine and the image is on a raised roll which deposits the paint, ink or dye as the material is fed between the printing cylinder and back-up cylinder.
(2) Four-color lithographing on continuous or thin sheet stock With this process the finished piece is lacking in depth of color because of the thickness of film.
(3) Spray painting with matrix masks.
(4) Silk screening on odd shaped subjects such as polyethylene pouf bottles.
(5) Hot stamping using gold leaf or other colored leaf.
(6) Roll painting.
(7) Vacuum plating on acrylic.



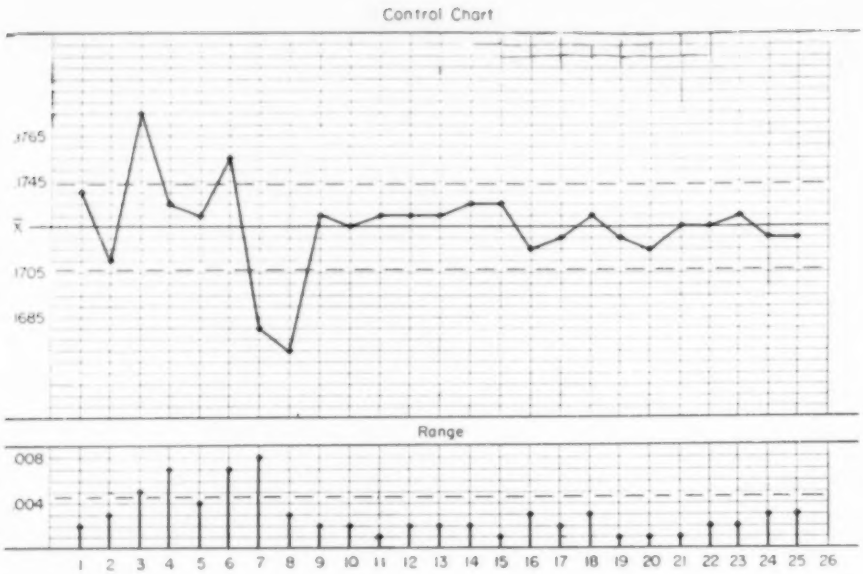


Figure 3. This control chart, kept posted while the operation proceeded, first showed an aim which was too high, then too low, and finally where it should be. The operator was also able to make another adjustment, after the seventh sample, which reduced the dispersion of results within each sample (the range results).

tolerance. Then, working backwards, one finds the allowed amounts of component tolerance for specification purposes. Both the larger component tolerances and the flexibility to allocate them in accordance with previous capability data have made possible many a job, which controlled by contemporary non - statistical quality methods would be impossible unless a selective assembly of components were used.

Since the favorable addition pertains only to statistically controlled processes, the specifications must require that control charts or their equivalent be used effectively.

Producer-Consumer Relationship

The customer of product from a vendor, contractor, or sub-contractor and the inspection department bear the same relationship to the production group. Although they always have the task of considering product for acceptance (usually through some means of checking) and they sometimes specify tolerances and standards, they never should be placed in the position of having to control quality. This viewpoint emphasizes the unsatisfactory nature of the almost universal practice of having the quality control and inspection people in the organization closely allied. That arrangement inherently dulls the possible effectiveness of the quality control effort. Usually one group reports directly to the other, and in certain cases there is even no such distinction between the two; just one department—Inspection and Quality Control Department, if not working under a still shorter name.

For the reasons already given in this article, the quality control group should be part of production. Inspection can well be separate.

(Please turn to page 52)

Specifications Under S.Q.C. . . .

(Continued from page 15)

units from the conventional sum of eleven. Each natural tolerance is squared, added, and the square root of the sum gives the assembly natural tolerance. Figure 4 shows distributions of shafts and bores, designed by specification to have a minimum clearance of .00075", giving actual assemblies of from .00225 to .00575".

This principle is a valuable by-product advantage to using a control chart to minimize the occurrence, duration, and extent of disturbance of assignable causes. In its usual application one starts with a required assembly

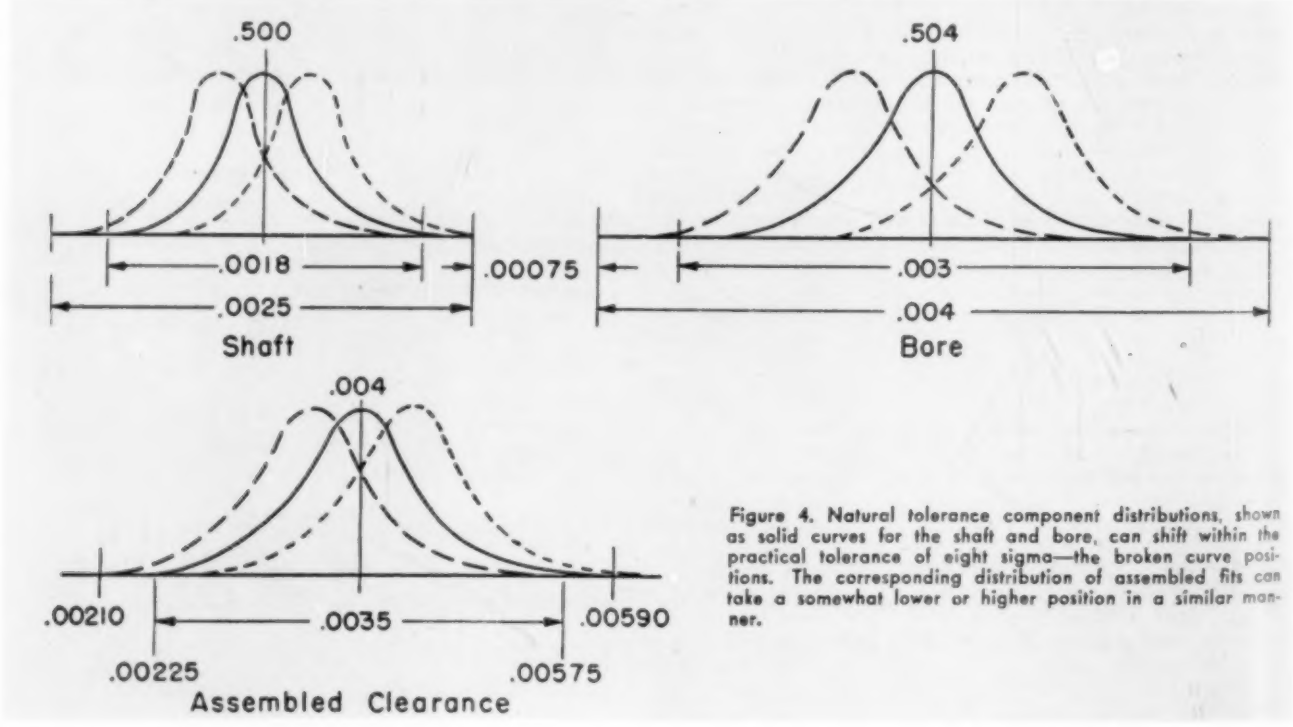


Figure 4. Natural tolerance component distributions, shown as solid curves for the shaft and bore, can shift within the practical tolerance of eight sigma—the broken curve positions. The corresponding distribution of assembled fits can take a somewhat lower or higher position in a similar manner.

Plastic Dies . . .

(Continued from page 23)

able plastic tool will become more apparent. As a result more and more new plastic applications will be found by the men charged with the responsibility of providing tooling for industry.

The laboratories of our industry are constantly at work to produce new and better plastic materials for tooling. When the overall possibilities are examined, it will undoubtedly be found in the years to come that we shall be able to produce and utilize plastic tooling that will be capable of forming sheet metal or light plate on practically any of the existing types of production equipment, or those known to be contemplated. The assistance of the tool engineers involved in this type of work is solicited by the tool plastic industry. This joint effort will permit expediting the development of these new materials and methods for the mutual benefit of all concerned.

Southeastern Ohio

Plastics and Printing

William J. Stranathan

The Southeastern Ohio Section of the Society of Plastics Engineers had 48 members attending the joint meeting with the Central Ohio Section at the newly constructed Y.M.C.A. building, Newark, Ohio.

Mr. J. Homer Winkler was the speaker of the evening and gave a very interesting and informative talk on the "Utilization of Plastics in the Printing Industry."

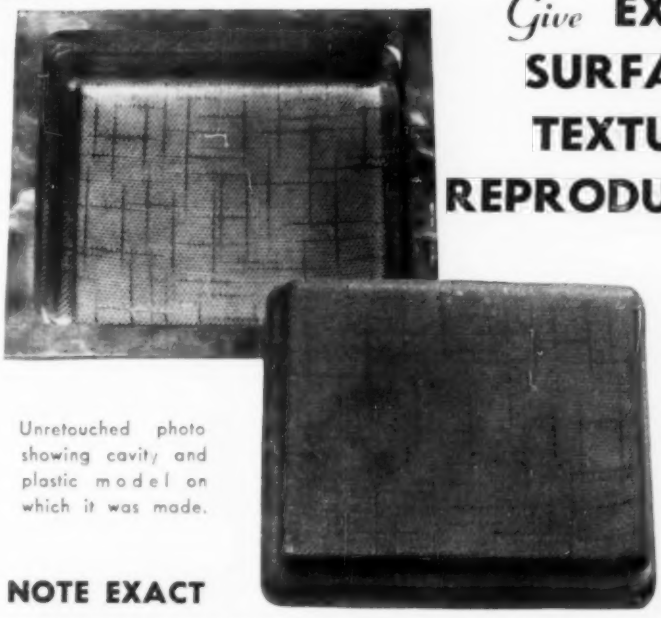
Mr. Winkler was at one time research associate in the National Bureau of Standards and has had long experience in the field of graphic arts.

Mr. Winkler explained in very close detail how the different methods of printing were done. Such as the photo-typesetting method which produces transparencies which are used in offset lithography and gravure. By the use of these transparencies not a single piece of type metal is used.

Another method is the Scan-A-Graver which is an electronic engraving machine used to produce celluloid halftones in about 20 minutes from a photographic copy. These Scan-A-Gravings can be printed from directly or can be attached to the outer surface of carved stereotypes for printing newspapers. They will withstand molding in the making of stereotype mats. This machine is used very extensively in the newspaper field in producing mats in a very fast and accurate manner. The old method took nearly four hours.

NICOFORM
ELECTROFORMED Molds

Give EXACT SURFACE TEXTURE REPRODUCTION



Unretouched photo showing cavity and plastic model on which it was made.

NOTE EXACT TEXTURE REPRODUCTION OF LEATHER SURFACE!

Nicoform electroformed mold parts bring great new possibilities to molded plastics . . . textured surfaces, greater accuracy, finer match lines, more detail at lower cost.

Nicoform cavities are hard (45-50RC), tough, corrosion resistant (good for Vinyl) and often cheaper than steel.

Nicoform cavities are made by depositing a hard nickel cobalt alloy over a model, which can be of plastic or other similar material. Every microscopic detail of the model, including **exact** size is reproduced in the nickel mold. The nickel is backed up with another hard alloy. Cavities and other mold parts are supplied ready to put in a mold.

Send for New Four Page Brochure

ELECTROMOLD CORP.

143 Enterprise Ave.
Trenton, N. J.

Specifications Under S.Q.C. . . .

(Continued from page 50)

This distinction shows up in the specifications under S. Q. C. Tolerances exist there as instructions to production. It is expected that they will strive, as a goal, to make all product conform completely. The concept of small or very moderate amounts of production permitted beyond tolerance limits is not a part of the *control* part of the specification. As a practical matter it would be rather difficult for a production group to produce just small or very moderate amounts of product beyond limits. It is much easier to make it all within limits. When trouble is unexpectedly encountered, unfortunately the usual experience is that a larger than "very moderate" amount of product is beyond limits.

There is an implied relationship between a very moderate *amount of product* beyond limits and the extent of the measurable error of the extreme pieces produced. In effect a specification that permitted this would be allowing slightly more room between the stated tolerance limits. Again, from the production department viewpoint, the concept is impractical; the difference is not big enough.

But there is a place in the specification for stating an Acceptable Quality Level (A.Q.L.), an Average Outgoing Quality Limit (A.O.Q.L.), or a Lot Tolerance Percent Defective (L.T.P.D.)—purely for the inspection groups. These terms and the philosophy of inspection will come in for some discussion in the next article on sampling.

Here, however, is a summary of the reasoning:

1. 100% inspection, in almost all cases, falls far short of effectively separating acceptable from non-acceptable product.
2. Besides being generally ineffective, 100% inspection often is uneconomical.
3. When inspection has to destroy product to determine its conformance to specifications, sampling is mandatory.
4. Sampling always involves risks of two types, of rejecting lots which, if their true defectiveness were known, would be acceptable (the case of small or very moderate amount of product beyond limits); and the risk of accepting quite defective lots, which would be rejected if their true defectiveness were known.
5. The numerical levels or values involved in these two types of risk can be part of the specifications. They determine the statistical sampling plan to be used by inspection. This is almost more effective than using 100% inspection indiscriminately, since its risk levels are unknown and uncontrolled.
6. Sampling is economical and readily shows acceptance of lots successfully controlled by production. Occasionally when production encounters trouble and a larger than "very moderate" amount of product is beyond limits, sampling also a controlled amount of the time rejects such lots for special handling considerations.
7. If work often comes to inspection quite defective from production, sampling is uneconomical and out of order since it may pass an occasional lot of this ilk. Special handling by inspection will have to be used while the quality control group in production is bringing about a correction of the situation.

In thinking about a specification, a producer wants limits great enough to accommodate his process capabilities, and a well-defined set of inspection instructions to avoid confusion. The consumer's point of view considers use requirements and competitive quality. Under S. Q. C. a "specification" can be established to achieve these goals. Without S. Q. C., one usually gets a "compromise" instead of a "specification".

Cellular Polyethylene . . .

(Continued from page 37)

HIGH FREQUENCY PROPERTIES

An application which requires this moisture resistance is the recently developed cellular polyethylene antenna lead-in wire for ultra-high frequency applications in that power factor and dielectric constant should be insensitive to changes in frequency. The presence of irregularities in either of these properties will result in power losses in the range of frequencies where the irregularities occur. In practice this might result in poor reception due to a weak signal in the case of the UHF antenna. The curves shown in Figure 5 show the behavior of this material over the frequency range from 10,000 cycles to 3,000 megacycles. It can be seen that both the power factor and the dielectric constant show little, if any, response to changes in frequency. This is a desirable situation as the absence of irregularities in either value means the power losses will be uniformly low.

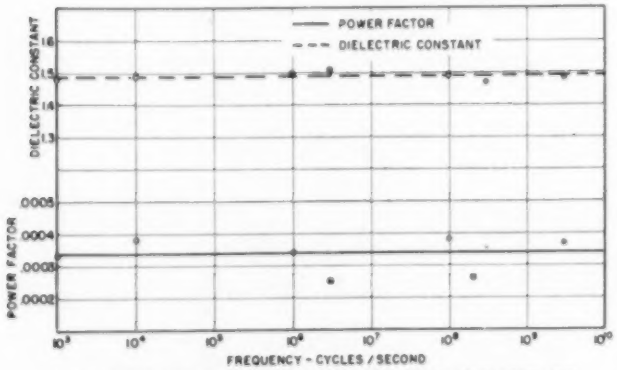


FIG. 5 POWER FACTOR AND DIELECTRIC CONSTANT OF CELLULAR POLYETHYLENE vs FREQUENCY

Life rings, fishnet floats, and other bouyant articles also require this kind of moisture resistance. Among the other applications contemplated for this unique material are closure liners, gasketing, low temperature thermal insulation cork replacement, and decorative uses.

For many applications a higher density than .47 may be required. This can readily be achieved by blending the cellular stock with a solid polyethylene compound to obtain the desired density. While it is possible to get higher densities by extruding at reduced temperatures and thus limiting the extent of blowing, it has been found extremely difficult to reproduce results. In every case it is recommended that all of the blowing agent be utilized.

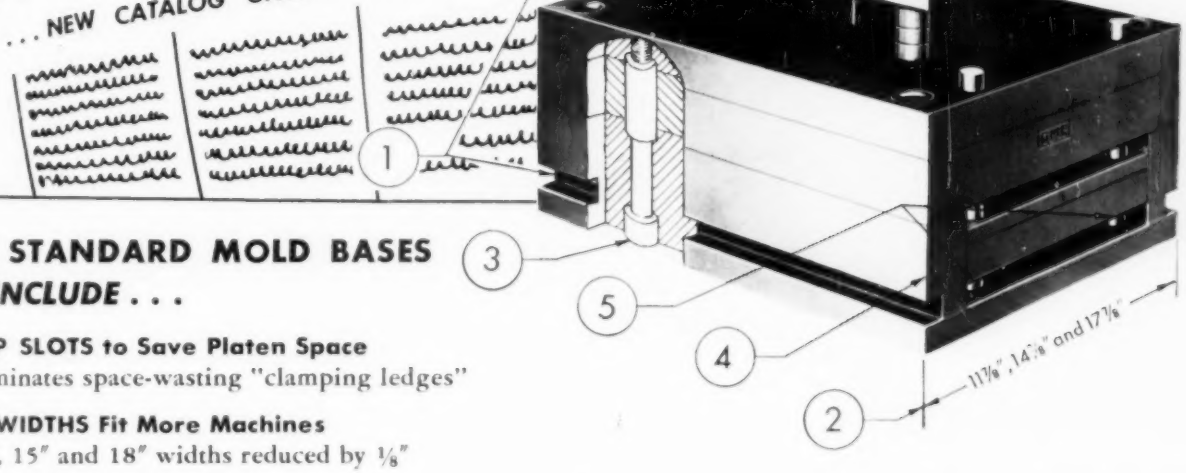
The unique properties of cellular polyethylene, the economies to be gained with its use by reduction in cable size and weight, and its ease of handling in modern extrusion equipment should open up many new avenues of approach to existing problems and to the introduction of plastics to new applications.

DME News

HERE'S BIG NEWS FOR MOLDMAKERS

NEW FEATURES ADDED TO MOLD BASE DESIGN

. . . NEW CATALOG GIVES DETAILS



D-M-E STANDARD MOLD BASES *NOW INCLUDE . . .*

1. **CLAMP SLOTS to Save Platen Space**
   Eliminates space-wasting "clamping ledges"
2. **NEW WIDTHS Fit More Machines**
   12", 15" and 18" widths reduced by ⅛"
3. **MORE ROOM for Waterlines**
   Tubular Dowels eliminate obstruction
4. **RIGID CONSTRUCTION with Less Parts**
   One piece Ejector Housing gives added strength
5. **STOP PINS WELDED to Ejector Bar**
   Prevents loosening and ejection interference

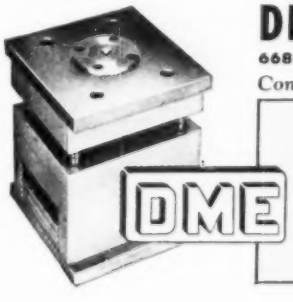
New 182-Page CATALOG Gives Complete Specifications and Prices . . .

The revolutionary features pictured here are now STANDARD on all D-M-E Mold Bases (except the 9" wide series). They represent the ultimate in Standard Mold Base development and are designed to give you the finest in mold base construction.

These added features make D-M-E Standards even more useful in saving you valuable time and money on all your moldmaking jobs!

If you have not already received D-M-E's Completely New CATALOG, contact your nearest D-M-E Branch TODAY! It contains complete mold base specifications as well as helpful design data and tables.

. . . it's the HANDBOOK of the Plastic Industry!



DETROIT MOLD ENGINEERING CO.

6686 E. McNICHOLS ROAD — DETROIT 12, MICHIGAN — TWinbrook 1-1300

Contact Your Nearest Branch FOR FASTER DELIVERIES!

HILLSIDE, N. J. (NEAR NEWARK) 1217 CENTRAL AVE., ELIZABETH 3-5840
CHICAGO 51, ILLINOIS 5901 W. DIVISION ST., COLUMBUS 1-7855
CLEVELAND 14, O.—D-M-E CORP. 5473 LAKE CT., ENDICOTT 1-0907
LOS ANGELES 7, CAL. 3700 SOUTH MAIN STREET, ADAMS 3-8214

CLASSIFIED ADS

POSITIONS FOR PLASTICS EXECUTIVES
$5,000—$50,000

The nation's largest executive agency presents an exclusive service for men in the plastics and allied industries. This is a confidential, professional and rapid service for the nation-wide placement of successful men under 45 in the engineering, technical, sales and administrative fields. Send a short resume including age, education and work history and we will tell you by return mail what we have available for you and how we can help. Write to H. Graebner at Graebner's Plastics Executive Exchange, 116 S. Michigan, Suite 705, Chicago 3, Illinois.

WANTED: Position in Administration or Production with thermoplastic company.

Education: B. Ch. E.; M. B. A.

Experience: Last four years spent in the manufacture of thermoplastic molding powder. Also, six years of additional administrative and industrial experience. Reply to Box 3054, 34 E. Putnam Avenue, Greenwich, Conn.

SITUATIONS WANTED
SALES AND ADMINISTRATION POSITION

15 years successful sales and management experience. Last 6 years in plastics. Operated Sales Agency. Created and managed plastics administration, sales, product development, advertising and promotion. Not an engineer. Two children. Age 37. Average earnings last three years $20,000. Prefer incentive program. Reply to Box 2954, 34 E. Putnam Avenue, Greenwich, Conn.

A Sporting Approach . . .

(Continued from page 34)

produced by one plant, in which all operations, such as fiberization, fiber finishes, collection, etc., are combined in one machine.

4. The availability of a lower cost plastic reinforcing material is indicated.
5. The increased strength contributed to plastics by parallel glass fibers, together with the fiber geometry of the material itself, suggest its use in many applications, such as:
   (a) Flat sheets and panels.
   (b) Cylinders (convolute or tape wound).
   (c) Springs.
   (d) Masts, spars, railings, etc.
   (e) Channels, I-beams and "hat sections".
   (f) Spheres (tape wound).
   (g) Archery bows and arrows.
   (h) Fishing rods.

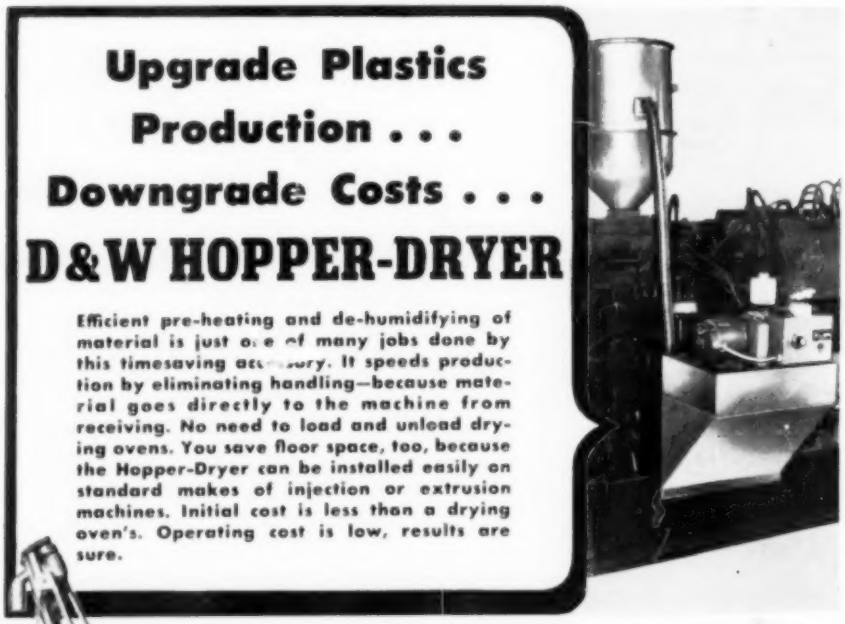
Bibliography

1. Robinson, Eugene, **"The Egyptian Composite Bow,"** Archery Magazine April '51 P1.
2. Klopsteg, **"Turkish Archery and the Composite Bow."**
3. **Technical Data,** Owens-Corning Fiberglas Corp. Publication PRs A1 Dated Aug. 18, 1952.
4. Andregg, F. O., **"Strength of Glass Fiber,"** Ind. Eng. Chem. 31 2[illegible] (1939)
5. Bainton, G. W. Jr., Guare, C. J. and Mathes, K. N., **"New Evaluation Techniques for the Effect of Glass Sizings on Glass Reinforced Plastics,"** Proceedings, Society of plastics Industry, Ninth Annual Conf., Feb., 1954.
6. Hindman, Harold, and Burr, G. S., **"The Instron Tensile Tester,"** Trans. ASME, October 1949.
7. Robinson, J. D., and Case, James W., **"Parallel Glass Fiber Laminates and New Resin-Glass Bonding Techniques,"** Proc. Soc. Plastics Ind. Ninth Annual Conf. Feb. '54.
8. Englander Co., Plastics Div., Baltimore, Md., **Final report on Contract Nord-13462** (Navy Bureau of Ordnance, Washington, D.C.)
9. U.S. Pat. No. 2,081,060

Upgrade Plastics Production . . . Downgrade Costs . . .

D&W HOPPER-DRYER

Efficient pre-heating and de-humidifying of material is just one of many jobs done by this timesaving accessory. It speeds production by eliminating handling—because material goes directly to the machine from receiving. No need to load and unload drying ovens. You save floor space, too, because the Hopper-Dryer can be installed easily on standard makes of injection or extrusion machines. Initial cost is less than a drying oven's. Operating cost is low, results are sure.



New Hopper Loader — For continuous automatic feed of any injection or extrusion machine. Clock timer control for starting and stopping. Dust-free operation. **"Die-Temp" Control** — Positive-acting, self-contained mold temperature control at any level between 100-400 degrees F. Fast, compactly built to save space.

Write today for complete information on how all three of these machines can help you.

THORESON-McCOSH, Inc. 18208 W. McNICHOLS RD. DETROIT 19, MICHIGAN PHONE: KENWOOD 1-8877

Plastic Pipe . . .

(Continued from page 18)

Potassium hydroxide manufacture. Plastic pipe feeds chlorine gas into KOH to bleach impurities.

TV tube manufacture. Plastic pipe handles 15% HF used in cleaning inside face of TV tube.

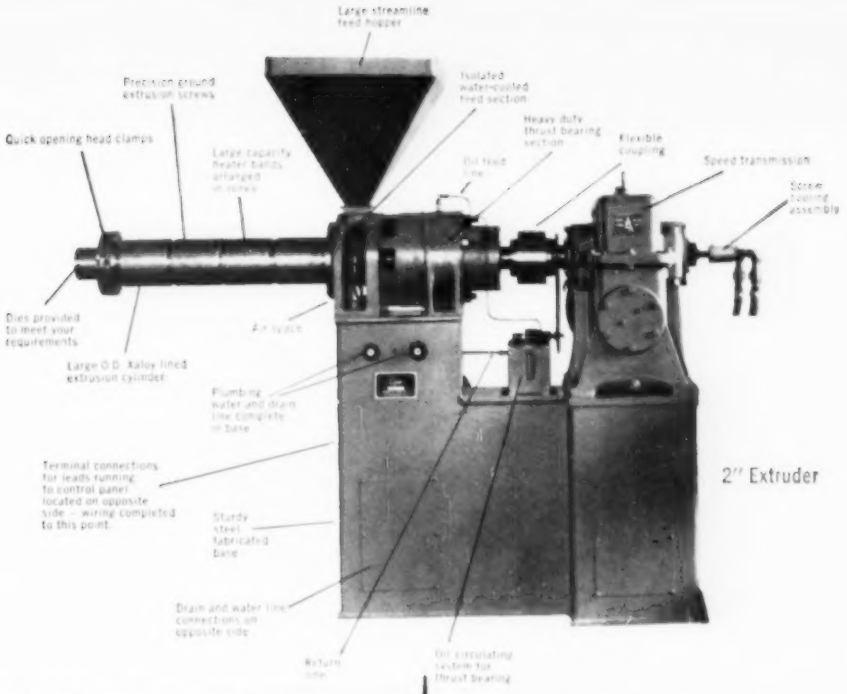
Plating operations. Plastic pipe handles Nickel, Silver, Copper, Brass, Gold, Lead, Tin, Chrome and Zinc plating solutions and Cyanide baths.

CONCLUSION

Plastics piping has, after many years of testing and trial installation, begun to gain volume acceptance in the handling of corrosive fluids in the chemical processing industry. To that industry plastics piping offers the promise, partially fulfilled, of reducing the cost of corrosion. Continued testing and wider use seems certain to follow.

To the manufacturer of plastic pipe the chemical processing industry offers a large market potential to be sought and cultivated with care and caution. Both the user and the manufacturer must remain aware of the limitations and must avoid expensive failures while they jointly prove the value of plastics piping in handling corrosive chemicals.

Egan plastic extruder


Large streamline feed hopper
Precision ground extrusion screws
Isolated water-cooled feed section
Quick opening head clamps
Heavy duty thrust bearing section
Flexible coupling
Speed transmission
Large capacity heater bands arranged in zones
Oil feed line
Screw cooling assembly
Dies provided to meet your requirements
Air supply
Large O.D. Xaloy lined extrusion cylinder
Plumbing water and drain line complete in base
Terminal connections for leads running to control panel located on opposite side — wiring completed to this point.
Sturdy steel fabricated base
Drain and water line connections on opposite side
Return line
Oil circulating system for thrust bearing

2" Extruder

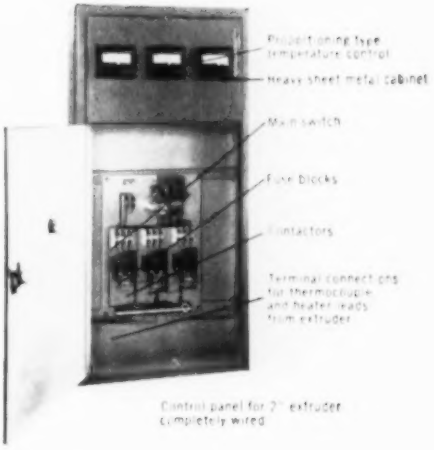
compare with the covers off!

Yes, when you remove the covers and get down to the bare facts of construction of this unique extruder, you will find a machine which will have longer effective screw lengths, greater maximum heating capacity, and larger thrust bearing capacity. This will add up to higher production rates, better products, and lower maintenance and operating costs. With the flexible design of the "extrusion" unit consisting of the separate components; screw, heating cylinder, feed section; and thrust bearing housing, we can give you any combination to meet your requirements.

EGAN EXTRUDERS are supplied complete with a *wired* control panel including the main disconnect switch, fuse blocks, contacts and temperature controls *mounted*. Plumbing for the water supply and return lines to the drain are completed in the base. Installation costs are held to a minimum.

EGAN EXTRUDERS can be furnished with dies, conveyors, take-off equipment and other auxiliary features for a wide range of extruded products.

Write for details or invite our representative to call



Control panel for 2" extruder completely wired

FRANK W. EGAN & COMPANY, Bound Brook, New Jersey

Designers and Builders of Machinery for the Paper Converting and Plastics Industries

Cable Address: "EGANCO"— Bound Brook, N. J.

Compare specifications of any standard Egan Extruder, size for size, with any other extruder.

Standard Sizes (Screw Dia.)—inches	2	2½	3½	4½	6	8
Effective Screw Length—inches	32	40	56	72	96	128
No. Cylinder Sections	1	1	1	1	2	2
Zones of Heating on Cylinder	2	2	3	4	4	4
Maximum Heating Load, KW	12	18	30	48	96	160
Thrust Bearing Capacity, 1000 lbs. @ 50 rpm.	60.5	60.5	119.5	208	288	420
Type Speed Transmission	Worm gear.	Worm gear.	Herr' bone	Herr' bone	Herr' bone	Herr' bone
Usual Motor Size, H. P.	7½-10	10-15	20-30	40-50	50-75	75-150
Approx. Extrusion Capacity lb./hr.	20-50	40-90	75-200	150-450	250-650	450-1200
Approx. Floor Dimensions—inches	40x98	48x112	60x120	84x132	96x156	104x192
Approx. Weight—lbs. (less Drive)	3200	3600	4800	6600	9600	12500

**Extruders are modified to meet requirements for a particular process*

hercocel®

FOR PRODUCTS ON THE MOVE

Nemo products are manufactured by Little Nemo Mfg. Co., Providence, R. I. and Nemo-Brier Ltd., Hull, Quebec, Canada

One look . . . and it sells! Brilliantly designed and exquisitely crafted jewelry and hair ornaments by NEMO are featured on chain store counters from coast to coast. High in quality, yet popularly priced, they are made possible by versatile Hercocel plastics.

Though mass produced to provide top value at lowest cost, the fine detailing and high styling of the new NEMO line reflect centuries of skilled hand craftsmanship. Hercocel's excellent compatibility with a wide range of richly colored lacquers accounts for the lasting brilliance and sparkle characteristic of all NEMO products.

Flexible but strong, Hercocel won't snap like more brittle plastics, splinter like glass or rust like metal. That's why "made with Hercocel" means your best buy in low cost, *high-quality* merchandise.

Cellulose Products Department

HERCULES POWDER COMPANY

930 King St., Wilmington 99, Del.